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By-Raymond, Roger A.

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Ninth and tenth grade students from two schools were placed in experimental and conventional instruction classes to compare the two methods in teaching algebra by means of achievement test and time needed to complete the course. Pre- and posttests measured aptitude; teachers and students in the experimental groups recorded personal reactions to the use of autoinstructional devices. Teaching machines presented the algebra program to be used at the student's own rate. Teachers commented on persistent boredom, the need for practice materials to supplement the programed information, and the advantage of individual work rates and self-help. Students felt a need for textbooks and teacher contact; 78% of the ninth graders said they would have learned more without programed materials. Mean differences between experimental and control groups do not support one teaching method over another. Recommendations are that analytic research be continued in the local school system, that the program at the tenth grade level be evaluated further, and that students be tested the following year for retention. Appendices contain teacher instructions on the use of the teaching machines, testing schedules, samples of the evaluation sheets, and anecdotal records. (TI)

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SIOUX FALLS PUBLIC SCHOOLS

E. W. Skarda, Superintendent

TEACHING ALGEBRA TO NINTH AND TENTH GRADE PUPILS WITH THE USE OF PROGRAMMED MATERIALS AND TEACHING MACHINES

ED023312

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October 1963

Dr. Robert W. O'Hare

Administrative Assistant to Superintendent

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CHAPTER I

INTRODUCTION

There has been an increase in the use of educational innovations throughout the United States in recent years that have met with considerable success. As a result, the Board of Education and administration initiated a research program in the school system to test some of these innovations for local use. Since one area in which there is much interest at present involves the use of teaching machines and programmed materials, it was decided to study the use of this material. Specifically, in the fall of 1962, it was decided following discussion by members of the administration and faculty, that one phase of the program would consist of a study to consider the use of such machines and programmed material in the teaching of algebra to ninth and tenth grade pupils. This study was subsequently begun and continued throughout the school year 1962-1963.

I. NEED FOR STUDY

Local school authorities wished to test the use of programmed materials and teaching machines in the instruction of algebra with ninth and tenth grade pupils. There are a limited number of similar studies available which have been conducted in various schools throughout the nation. It was felt, however, that the number of such studies was not sufficient. Also, it was felt that a local study should be made to determine how the results would apply under local conditions. In addition programmed materials and teaching machines are relatively expensive and it was deemed prudent to determine their usefulness, feasibility, and effectiveness before consideration is given to their purchase in large numbers.

II. STATEMENT OF THE PROBLEM

This study was designed to compare two methods of teaching algebra: by the conventional method and with use of programmed materials and teaching machines. It is also designed to provide descriptive analyses of the use of programmed materials and teaching machines. More precisely the objectives of the study were:

1. To compare standardized algebra test results between control and experimental groups.
2. To compare standarized study method inventory results (attitudes toward school, mechanics of study, planning and system subscores) between the two groups.
3. To present descriptive analyses of the use of programmed materials and teaching machines.
4. To compare time needed by each group to complete the program.

III. PROCEDURE USED FOR THE STUDY

The study was designed to include the following procedures:

Sample

Two teachers were selected for participation in the program. One was from a junior high school and taught one control and one experimental class at the ninth grade level. The other was from the senior high school and taught one control and one experimental class at the tenth grade level. All classes were composed of students placed in their group on a random basis with no attempt to group homogeneously. However, the tenth grade classes represented students who were taking algebra one year later than it is usually taken. This was due to various factors which include the student's failure of the subject at the ninth grade level and the student's wish to take general math in the ninth grade before taking algebra.

Classroom

The experimental group consisted of one class each of ninth and tenth grade students. In each case their classroom experience was based on one regular class period daily during which they studied first year algebra by the use of programmed material and teaching machines. When the individual student completed a given unit of this material he proceeded to the next unit at his own speed.

The control group consisted of one class each of heterogeneously grouped ninth and tenth grade students. In both cases the classroom experience of the control groups was based on a regular algebra course taught in the traditional manner using typical textbooks for one regular classroom period per day. The course continued for the entire school year.

Testing

The control and experimental groups were administered the following tests at the beginning of the experiment: intelligence, standarized algebra, an algebra test based on the programmed material, and a study methods survey (subscores in attitude toward school, mechanics of study, planning, and system). The intelligence test was not repeated at the close of the experiment as it was used only to check on I.Q. variance for the four groups. The other three tests, however, were given again at the completion of the experiment. Those students using the teaching machines were tested individually as they completed the programmed materials. Students in the control group were tested when they completed the course in the spring.

Each teacher maintained a descriptive anecdotal record for their experimental group containing comments regarding routine as well as unusual happenings. In addition they reported their reactions and attitudes on an evaluation sheet.

Each student in the experimental group maintained time records. They also completed an evaluation sheet at the end of the course in which they expressed their reactions and attitudes.

Following is a list of the evaluation instruments used in this research project:

1. Pre and Post Tests
   A. Lankton First-Year Algebra Test
   B. Algebra Test Based on Programmed Materials
   C. California Study Methods Survey
2. Pre Tests Only
   A. Otis Gamma Intelligence Test
3. Others
   A. Teacher's Anecdotal Records
   B. Student's Time Log and Commentary
   C. Teacher's Evaluation Sheet
   D. Student's Evaluation Sheet

See appendix for samples of these materials.

Descriptive Analyses

These analyses consist of an account of the experiment which describes procedures and reports routine as well as unusual happenings. An attempt is made to report the reactions, feelings, and attitudes of teachers and students to programmed materials and teaching machines. What type of student did the machines seem to motivate? Which type did they fail to motivate? What significant changes in student behavior might be due to the experiment? Anecdotal records and evaluation sheets of students and teachers are used to support this phase of the investigation. Time records maintained by the students are also analyzed in this phase of the program.

Statistical Analysis

Intelligence tests were administered to the control and experimental groups to determine whether this variable needed to be controlled statistically. From a test of statistical significance it was determined that for the purpose of this research study such controls were not required.

Further tests of statistical significance were made on the pre and post algebra test and the attitude-towards-school inventory. These tests were based on three levels of ability as determined by the intelligence tests as well as by total groups

IV. ORGANIZATION OF THE REMAINDER OF THE STUDY

The remainder of the report deals with a review of the related literature on the teaching of algebra through the use of programmed materials and teaching machines, a descriptive report of the methods and procedures used in the two groups, an analysis of teachers' anecdotal records and evaluations, an analysis of students' reports and evaluations, a statistical analysis of the data, and conclusions reached.

CHAPTER II

REVIEW OF RELATED LITERATURE

The field of programmed instruction and teaching machines or auto-instructional devices is a developing field still in its infancy. Changes are occuring almost daily. It is very difficult, for example, to maintain current information relative to new programs and new types of machines available. The number of research studies in this area is increasing rapidly also.

An NEA Journal contained a glossary relative to programmed instruction. It defined:

> GLOSSARY
>
> Auto-instruction (self-instruction). A comprehensive term denoting an instructional process that usually involves carefully planned materials and devices designed to produce learning without necessarily requiring additional human instructional assistance.
>
> Program. Subject matter arranged in a carefully planned series of sequential items and involving (a) controlled presentation of material, (b) active response of learner, (c) use of cues (prompts) to elicit correct responses, (d) immediate confirmation of success or failure (feedback), and (e) reinforcement of correct responses in such a way as to enable individual learners to move ahead, independently and at their own pace, from familiar background to new and previously determined terminal behavior. Programs may be presented in books, in loose-leaf binders, in special machines, and in other ways.
>
> Teaching machine (auto-instructional device). A mechanical device by

> which a program is displayed to a learner. It usually presents one frame (item) at a time, provides some method for the student to indicate an overt response, shows whether response is correct or not, prevents cheating by student, maintains a record of student responses; enables use of nonverbal programs, that is, programs which are either totally or in part presented in audio and/or visual form.[1]

A special brochure prepared by the National Education Association contained the following pertinent information:

> WHAT IS A TEACHING MACHINE?
>
> Various types of instructional equipment which the individual student uses at his own rate of learning are popularly known as teaching machines, although authorities in the field prefer the term auto-instructional devices.
>
> They may be simple or complicated, toy-like or computer-like, inexpensive or costly, but all teaching machines have certain characteristics that distinguish them from more traditional audiovisual equipment.
>
> ..They are designed for the individual student (one machine and one student) rather than for mass instruction of an entire class at one time.
>
> ..The machines require active response from the student who must manipulate them in some manner to indicate his responses to questions or problems they present.
>
> ..Teaching machines tell the student immediately whether his answer is right or wrong, providing reinforcement, an extremely important aspect of the learning process.
>
> ..Teaching machines present a certain organized program of material that may be tackled by the student at his own rate of learning.
>
> Most teaching machines are cheatproof and do not allow the student to see the correct answer to a question or problem until he has recorded

---

[1] National Education Association, Teaching Machines and Programed Learning, A Glossary Prepared by the Staff of the NEA Journal (Washington: National Education Association, 1961), p. 15.

his own. Some give only the correct answer; others explain why a student's answer was right or wrong. Most will not allow the student to proceed to complex problems until he has correctly solved the simpler ones.

WHAT ARE PROGRAMMED TEXTBOOKS?

Closely related to teaching machines are programmed textbooks which look like any textbook externally, but which are quite different in make-up. The programmed text presents in proper sequence the separate steps, or questions, that make up the program. Answers to these questions appear in the book on subsequent pages.

Although the programmed text has much in common with the machine, it neither prevents the student from looking at the answer prior to answering the question nor controls other aspects of student behavior --aspects which can be prevented by machines or which machines can take into account. According to some studies this type of "cheating" appears to have little effect on learning, especially at the more advanced educational levels.

ARE TEACHING MACHINES SOMETHING NEW?

Not exactly. Although they have been in general use in public elementary and secondary schools for only four or five years, teaching machines have been used in colleges much longer, and the armed forces have been doing much technical training by machine for at least 20 years. The first teaching machines, as we know them, were developed more than 40 years ago and have been used in limited numbers and for experimental purposes ever since.

WHY HAS THEIR DEVELOPMENT LAGGED?

Fear, cost, and lack of adequate programs are the main reasons that teaching machines did not come into popular use sooner. A few teachers have feared for their jobs, and some parents have feared that their children would not be treated as individuals where teaching machines were used. Costs of machines and programs have been greater than many districts have wanted to pay, expecially when they suspected that, by waiting, more advanced materials might be put on the market at lower prices. Most important has been the shortage of programs for general use in the schools. However, much work has now been done on programming instructional material for most elementary- and secondary-school subjects, and these programs are now ready for wide experimental use in the schools.

IS IT TRUE THAT TEACHING MACHINES MAY REPLACE THE TEACHER?

No, definitely not! At the turn of the century, Thomas Edison predicted his motion-picture projector would do away with the need for teachers. Earlier, similar sentiments were expressed about the printed book. But like automatic washing machines and housewives, teaching machines and teachers have different purposes.

Machines can instruct and tutor and thereby help a teacher give students information and drill on an individual basis. The teacher is thus freed from much routine work and has more time to help students learn, individually and collectively. Though his role may change womewhat as more and more technological devices find acceptance in the classroom, the teacher remains the central figure in the instructional program.

WILL TEACHING MACHINES REPLACE TEXTBOOKS?

They will not replace textbooks, but undoubtedly they will have a considerable effect upon them.

However, not all material can or should be programmed. The good teacher will add the teaching machine to her storehouse of instructional devices. It will supplement, not replace, textbooks and the other time-tested audio-visual aids at the teacher's disposal.

WHO CAN LEARN WITH TEACHING MACHINES?

Nearly all students can benefit from teaching machines. Significant success has been recorded both with those who require considerable individual attention at a slow pace and those who need freedom to proceed as rapidly as possible. Makeup problems are reduced and varied needs and interests are met more adequately when teaching machines are used.

Teaching machine programs are constructed to provide motivation to the curriculum. They force habits on students by the way the material is presented and by the constant demand for immediat e, active student response. These habits seem to carry over into traditional learning experiences to the benefit of all types of learners.

HOW DOES LEARNING BY MACHINE COMPARE WITH LEARNING BY STANDARD TEACHING?

Research indicates that some students are able to learn much more and much faster when teaching machines are used to supplement standard classroom procedures. These is still some fear that teaching machines may destroy creativity, but research has not found this to be true. What machines can do for a student over a long period of time remains to be seen. Much more research is needed in this very promising area of education.

WHAT SUBJECTS CAN MACHINES TEACH?

In theory, any subject that can be verbalized can be programmed. To date, the largest number of programs have been developed in arithmetic, mathematics, and the sciences, although a programmed course in creative writing (among other subjects) is now being developed. Military and industrial personnel are being taught technical and occupational skills as well as traditional school subjects via teaching machines.[2]

Hilgard[3] has stated that programmed instruction derives its support from established principles in the psychology of learning. He listed six principles which support this: programmed instruction recognizes individual differences by beginning where the learner is and permitting him to proceed at his own pace; programmed learning requires activity on the part of the learner; immediate knowledge of results are available; the organized nature of knowledge is emphasized because it requires continuity between the easier and harder concepts; in order to guarantee a high degree of success spaced review is provided; and finally, programmed instruction reduces anxiety because the learner is not threatened by the task.

Research has been conducted in the teaching of arithmetic and algebra as well as into the development of understandings in mathematics by the use of teaching machines and programmed materials. Lumsdaine[4] quotes the following in his book:

---

[2] National Education Association, Teaching Machines and Programmed Instruction: An Introduction for Students and Their Parents, A Report Prepared by the Staff of the National Education Association.

[3] Ernest R. Hilgard, "What Support from the Psychology of Learning?" NEA Journal (Washington: National Education Association, 1961), Vol. 50, No. 8, pp. 20-21

[4] A. A. Lumsdaine and Robert Glaser, Teaching Machines and Programmed Learning (Washington, D. C.: National Education Association, 1960), p. 425.

> The use of teaching machines for the teaching of spelling and arithmetic combinations has already been shown to have merit (Skinner, 1954; Pressey, 1927). And studies have demonstrated that automated teaching can result in more than simple rote learning (Porter, 1957; Ferster and Sapon, 1958).

Kate[5] reported a study using Grolier programmed texts in algebra. The experimental group included twelve boys and two girls ranging in age from 15 to 19 with a mean age of 16 1/2 . Intelligence quotients for the group ranged from 83 to 112 with a mean of 97. Of the group all but one had failed the first semester of a regular algebra course. Kate further reported that all of the students began the programmed course with some degree of enthusiasm and indicated this to be the result of renewed hope of passing the algebra course.

The pertinent material from his study is contained in the material quoted directly as follows:

> In summary, I do not feel that this class acquired a very extensive knowledge of algebra. There is no doubt however that more was accomplished by placing them in this class, where they did actively participate, than leaving them in their regular classes, where most of them were merely occupying a seat. Six of them did pass the course, whereas it is doubtful if any of them would have passed in their regular class.[6]

Alter[7] describes a study in which 236 students from the seventh to the eleventh grade with a mean I.Q. of 116 worked with programmed material that dealt with Sets, Relations and Functions. Two hundred thirty-five frames were included in the material. The range of time required to complete the program was from 60 to 130 minutes with the mean at 85 minutes.

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[5] Richard M. Kate, Case Study II, Some Representative Annotated Case Studies of the Use of TMI-Grolier Programmed Materials During the 1961-62 School Year: A report Prepared by the Teaching Materials Corporation, Divison of Groiler Incorporated, New York.

[6] Ibid.

[7] Millicent Alter. Retention in Programmed Instruction. Technical Report 620917. The Center for Programmed Instruction. September 1962.

Following the program the subjects were divided into seven groups with roughly equivalent scores on the initial post test. After an interval of 2, 4, 6, 8, 10, 12, and 30 weeks the same tests were repeated. The results of this testing indicated that the initial post-test achievement score was found to be the best predictor of retention and that I.Q. predicted initial post-test achievement and was thus also a predictor of retention.

In addition, the students were grouped into high, middle, and low groups as a function of initial achievement. No significant differences were found in the retention curves for the three groups. Likewise, with initial achievement held constant, the decline in retention over the times used showed a parallel pattern for the high, middle, and low I.Q. students. This same relationship was also found regardless of whether or not the students completed the programmed material rapidly or slowly.

Although many conflicts are reported in the results of research studies relative to teaching machines, most studies describe the superiority of the machine method over teacher method. When such comparisons are not made, the research study usually points out many advantages of teaching machines and programmed materials.

CHAPTER III

METHODS USED IN THE RESEARCH

Students who participated in the project were drawn from two schools: tenth graders from Washington Senior High and ninth graders from Edison Junior High. In both buildings the students were randomly placed into experimental and control groups. Both control sections were taught first year algebra by traditional methods while both experimental groups were taught by use of programmed materials and teaching machines.

The same teacher handled the control and experimental groups at the ninth grade level. A similar relationship existed at the tenth grade level.

All classes were composed of students placed in their particular group by the usual random assignment to class sections followed in the particular building. However, as previously noted, the tenth grade students represent a somewhat special case in that they were taking algebra one year later than it is usually taken. This was due to a number of reasons which include: the students failed the subject at the ninth grade level; they chose to take general math in the ninth grade before taking algebra in the tenth; or for various personal reasons they chose to take algebra at a time other than the ninth grade year.

I. THE TIME FACTOR

Due to the late arrival of the teaching machines and programmed materials, some comment is in order concerning the time involved in this project. In the case of the ninth grade students the teaching machines and programmed materials were put into use on October 2. Prior to this time the students in the experimental group spent their class time in the study of base two and base five number systems. At the tenth grade level the experimental group began using the programmed material on October 3. Prior to this these students spent their class time in the study of introductory text book material.

Both control groups began the study of first year algebra by conventional methods at the opening of the school term. They completed their instruction at the close of the school year in the spring.

Students in the experimental group worked at their own speed and as a result completed differing amounts of material. Two tenth grade students completed the entire program and five ninth grade students completed the material by the end of the school year. It was felt by the teacher that had the ninth grade group begun at the start of the year, the majority would have finished the entire program. Table I, page 16, shows the number of units of programmed materials completed by the students by the end of the year.

II. THE EXPERIMENTAL GROUP

Both experimental groups received their algebra instruction through the

TABLE I

NUMBER OF STUDENTS IN EXPERIMENTAL GROUPS COMPLETING VARIOUS NUMBER OF UNITS

GRADE	UNITS COMPLETED											
	5	6	7	8	9	10	11	12	13	14	15	16
9			1	2	3	7	3	4	2	0	0	5
10			1	0	3	4	11	1	1	0	2	2
TOTAL 9 & 10			2	2	6	11	14	5	3	0	2	7

use of programmed materials and teaching machines. TMI - Grolier's Fundamentals of Algebra: Self-Tutoring Course was used in conjunction with the Min/Max teaching machine.

The publishers list the programmed material as Parts I and II. Part I consists of 1933 frames of material. Records gathered by the publisher indicate that the majority of students complete this material in from 15 to 25 hours. Part II consists of 4400 frames and takes most students from 35 to 50 hours to complete.

A sixth grade reading ability is required in the opinion of the publisher to successfully complete the material. In addition the student is expected to have a command of the four fundamental operations with whole numbers, fractions, and decimals. The publishers indicate that the material has been successfully completed by seventh grade students, but it is generally used at the eighth and ninth grade level.

While the research program was in progress the machines were kept in the classroom. Easy access to the material permitted the full use of class time with the materials: an average of 50 minutes per day was used for algebra class. An Answer-Mate was attached to each machine. This is an attachment that uses a roll of adding machine tape on which the student writes his answer to each frame thereby permitting the programs to be reused.

Each student in the experimental section had his own machine and proceeded at his own rate. With the exception of receiving help from the teacher as he wished, each student worked independently.

Tests were constructed by the publishers for use at the beginning and end of the programmed units. Students took these before attempting each unit and again at the completion of each unit.

It was decided by the teachers that the pupils would repeat the unit if they did not attain a minimum score on the post unit tests of 60 per cent. Although this was not conceived as part of the original design of the project the approach was allowed. As a result a number of the students repeated units during the course of the year.

Letters and an explanation of teaching machines and programmed learning (see Appendix A) were sent to parents of students in the experimental group. Parents were encouraged to seek further information from school officials if they desired.

A meeting was held with the two teachers prior to the project. At that time information (see Appendix B) was released concerning the teachers' participation in the experiment.

Instruction sheets (see Appendix C) were distributed to students in the experimental group. These include instructions regarding the use of programmed materials and teaching machines.

III. CONTROL GROUP

Students in the ninth and tenth grade control groups received instruction in algebra through the conventional methods and materials in use in the local system. Teachers other than the two participating in the research received the same materials and help. Approximately 50 minutes per day were devoted to classroom instruction in algebra.

CHAPTER IV

ANALYSIS OF TEACHERS' ANECDOTAL RECORDS AND EVALUATIONS

Teachers involved in the study made two types of evaluations: a written daily log of both routine and unusual happenings and an evaluation that was completed at the close of the school year.

I. TEACHERS' WRITTEN LOG

Both teachers maintained their daily anecdotal logs during the year (see Appendix D). In the beginning the entries suggested a certain amount of frustration as evinced by the following excerpts:

> 10-3 All students exhibited enthusiasm and very eager to commence the new course. Some of the students experienced difficulty in operation of the machines. Most difficulty caused by sheets of questions becoming jammed in the internal rollers. This is purely mechanical and I'm sure will work itself out.
>
> 10-3 The machines (some) were temperamental and considerable time was spent in removing sheets which had jammed. (__________) had a machine that refused to feed. One machine jammed and ruined the first two sheets of Unit 1. These two people accomplished nothing this period.
>
> 10-4 Spent most of the hour with various machines -- getting them to work if possible.
>
> 10-4 Several of the students were disturbed because machines were not functioning properly.

Following this initial confusion and the replacement of defective parts both experimental groups began to function in a more relaxed and profitable learning atmosphere. The following comments appear to bear this out.

> 10-8 New inside units arrived and are gradually being installed. All students have finished the test on Unit 1. Gradually the students are separating as to where they are working in the program. No one has started Unit 3 at this time.
>
> 10-10 As of this date the students appear relaxed and are concentrating upon their work. To date two students have completed Unit 3 and will be starting Unit 4 on Monday.

By the end of the first three weeks of use the concern shown was no longer over the machines, but with the students progress or lack of the same. The following material indicates this concern by the teachers.

> 10-9 (________) seems to have a weakness. It may be in reading or it may be in math ability although her numerical ability in the DAT is 61 and verbal reasoning 45. I'll keep watching her. It may be a weakness in seeing relationships in comparisons.
>
> 10-17 (________)has repeated Unit 3 twice but is still having trouble. Plan to give her some textbook work on the side. I'm of the opinion her trouble is lack of mastery of arithmetical combinations in addition, subtraction, multiplication and division.
>
> 10-24 The students working on Unit 6 are encountering some difficulty. One failed to pass the post unit test and is now taking the unit programming over. Removing and restoring parentheses appears to be giving the student the most difficulty.
>
> 10-29 Unit 6 seems to be presenting difficulty. Subject matter deals with equations and parentheses. Understanding of how to clear equations of fractions seems to be giving the students the greatest difficulty.

Both teachers made a number of comments regarding the need for supplementary materials for practice by the students in addition to the programmed information. The following statements from the anecdotal log illustrate this need.

> 10-24 (________)asked for a text today to review solving simple equations. Worked out two sheets full and submitted them. I have a feeling of little contact with my students at this time.
>
> 11-2 More students are asking to use books to supplement the work on the programmed material. In all cases they want to have more practice in solving various types of equations. I think when we get through Unit 7 (signed numbers) the work on equations will become easier.
>
> 11-7 To date all except one student has completed the first five units. For the type of student enrolled in this class at Washington Senior High School there is not enough drill work in the units.
>
> 11-14 More and more students are reverting to text books for practice. It would seem that they feel the need of working more problems than are provided by the program.
>
> 12-4 I think that some algebra problems should be mimeographed on separate sheets of various types. These should be graduated levels of problems. When students finish certain areas or units these challenges could be given to them to help confirm their knowledge of the particular subject matter being studied.
>
> 3-20 It has been necessary to give some of the students additional work at the board on the four fundamentals of polynomials and factoring. After completing a particular process -- say division -- the student does not understand the process.
>
> 3-26 Comment for the day --- slow students need more problems in a specific operation to become skilled in that particular operation.
>
> 3-28 Programmed instruction supplemented by individual work at the blackboard or by referring the student to algebra textbooks that are available in class. This is necessary in order that the slower student may master the processes of factoring.

Boredom with the programmed material developed toward the end of the first semester. The following excerpts tend to illustrate the feelings regarding the routine use of the programmed materials.

> 12-12 Things seem very calm. I'm not sure whether it is boredom or just plain algebra that doesn't cause trouble.
>
> 12-13 I think that some provision should be made to break the constant frame study by having a day for tests; a day for discussion, etc.

> Homogeneous grouping may be the answer so that this can be done. I realize this partially defeats the individual progress idea.
>
> 1-3 There seems to be more and more quiet resignation settling in. There is very little eager attitude left. The students work hard and seem to be getting it but you don't see the sudden understanding that shows up on some students' faces from time to time.
>
> 2-2 To break the monotony the class had a discussion on what they think of learning algebra via machines.

Individual problems and help for the individual with these difficulties are illustrated by the following. With the exception of the first two items the comments relate to the tenth grade experimental group. This does not mean to imply that individual assistance was not required by ninth grade students. Rather, it illustrates that the tenth grade people, being the somewhat select group previously defined, had more difficulty with algebra.

> 1-22 A short review of signed numbers is necessary for a few students. This will be done tomorrow.
>
> 2-18 This long time with nothing to report must indicate something, but I don't know what. The students are working in the second box which seems to be better programmed, better than the first box (part I). Very few questions during this area and they are mostly questions on procedure rather than understanding of the problem.
>
> 11-13 Today students were requesting more individual instruction than heretofore, especially Units 6 and 7. Majority of my class time was spent giving pupils assistance in clearing up processes that they did not understand.
>
> 11-29 For the past three days considerable time has been spent with the students who are the last ones to do Units 7, 8 and 9. The slow student appears to be encountering a greater amount of difficulty in understanding the process involved in the mentioned units.
>
> 12-6 Seems more and more of my class time is being spent assisting the slower students on the latter units of the program. I'm sure that all the students will complete the course by the end of the first semester.

1-9 Again, spent considerable time giving individual instruction and explanations to students on Units 9 and 11.

3-18 A majority of my class period is spent giving individual instructions to students having difficulty with Unit 5 involving factoring.

3-22 Comment for the day -- slow students need more problems in a specific operation to become skilled in that particular operation.

4-18 In general, my job the past few days has been to teach, reteach, review, recall, explain and what have you in classroom activity. What with the low calibre student in this type of class such procedure can be expected.

4-22 The entire class period today was spent assisting students working in Units 5 (fractions), Unit 6 (fractional equations) and Unit 7 (word problems).

4-23 Generally, about six students of the class need extra instruction and explanation on every unit they are engaged in working. Perhaps one can say that this is the purpose of programmed instruction -- a handicap to most of the students is that they cannot remember from one day to the next.

5-6 Continue to give assistance to the slow students, however, not as frequently as heretofore. It is my hope that all of the students will complete Unit 11 by the latter part of May.

5-8 Extra explanation appears necessary every day for the slow learners. At this time of year some of the students that I have would much rather be on the outside than inside the school.

5-16 A large portion of the class period is still devoted to individual instruction.

Many favorable comments can be quoted regarding the course. A few of these are recorded below:

10-8 Students progressing rapidly. All have completed Unit 1. Several are almost through with Unit 2. Grades on post Unit 1 test were B and higher.

10-10 As of this date the students appear relaxed and are concentrating upon their work. To date two students have completed Unit 3 and will be starting Unit 4 Monday.

> 10-15 The growth shown between the pre unit and the post unit tests thus far has been encouraging. For example, students on pre unit tests may get as many as six wrong out of ten questions. On the post test a student may miss one or two or even get all ten questions correct.
>
> 10-18 Grades on post unit test thus far are running higher than anticipated. Pre test grades were C or better.
>
> 1-2 The students, after vacation, started in where they left off without much trouble. There seemed to be very little review to refresh their memories.
>
> 1-9 I have one student on Unit 9, but considering his abilities he is doing wonderful work, in my estimation.
>
> 1-16 At this point all but 4 of the students of the 29 are on the second box. (Keeping in mind we started four weeks late in the fall, this will give some indication of the time element).
>
> 3-18 The students have developed the idea of self-help in many cases. When they don't do well on a unit they immediately check out a book to work on that area. I make it a point to let them ask rather than ask them. It's amazing.

The general pattern of reaction to the course seems to be: frustrated exasperation over balky machines, concern by the teachers over student progress, boredom with the fixed pattern of activity that comes with the exclusive use of the programmed materials, followed by a developing contact between students and teachers through the use of supplementary materials, traditional teaching methods, and a growing awareness on the part of the students to help themselves.

A number of recommendations appear in the teachers anecdotal records. These follow:

> 10-10 It would be nice if the answer mate could be attached to either side for left-handed persons.
>
> 10-25 Today we took the tape out of the gears of the answer mate.

We now pull it thru by hand. This not only saves a lot of tape but the room is much more quiet.

12-4 I think that some algebra problems should be mimeographed on separate sheets of various types. These should be graduated levels of problems. When students finish certain areas or units these challenges could be given to them to help confirm their knowledge of the particular subject matter being studied.

12-10 A roll of Scotch "magic" tape repairs easily the papers that sometimes are torn in the machines. Once in awhile a set of papers go backwards through the gears from underneath and are torn.

12-13 I think that some provision should be made to break the constant frame study by having a day for tests; a day for discussion, etc. Homogeneous grouping may be the answer so that this can be done. I realize this partially defeats the individual progress idea.

12-18 I think a ditto copy of supplementary work for every unit should be constructed so that the students could have something to work on over and above the unit itself.

4-30 I have one suggestion to make if programmed instruction is to be continued in Washington High School next year -- students weak in mathematical fundamentals and word comprehension should not be enrolled in such a course. Just a suggestion, mind you.

II. TEACHERS' EVALUATION FORMS

Teachers in the experimental group completed an evaluation form at the end of the school year (see Appendix E). The first question asked was: "Is the subject matter of the program academically sound?" One teacher answered yes with the following comment:

> Subject matter is similar to the conventional method used at Washington High School. Covers identically the same material.

The other teacher answered the question as being undecided with the following comment:

> There seem to be some gaps in the program. Probably the lack of

enough types of problems.

The second question was: "Was the level of the subject matter appropriate for your class?" Both teachers answered the question yes with the following comments:

> Some of the better students complained about the small steps in structuring a problem.
>
> Generally the subject matter was appropriate. The program was structured to meet the reading ability and fundamental concepts appropriate for the type of student here at Washington High School.

Question number three was: "As contrasted with what you have been able to accomplish with other types of learning material, how much do you feel you were able to get your pupils to learn with this program?" Both teachers indicated they felt they were able to get their students to learn about as much as with other materials.

Their comments regarding this question were as follows:

> I would say that the student in this course does not have the breadth of knowledge (as many kinds of problems) as in a conventional course.
>
> The slow learners benefited from this type of program as compared to the conventional method. Competency in fundamentals and other processes more meaningful.

The next question was: "The next time you teach a course in this subject or a similar field, would you: (a) Prefer to have programs used for at least part of the course? (b) Prefer not to have programs used? (c) Not care whether programs are used or not?" No answers to the question were given by the teachers, but their comments were as follows:

> Prefer to teach this subject entirely by program.

> I would rather teach this course a second year before commenting on this question. I don't feel that one year with a slow start can give a complete picture.

Question number five was: "To what extent did you enjoy using this program with your class?" On a scale which ran as follows: Very Unenjoyable, Unenjoyable, 50-50, Enjoyable, Very Enjoyable, one teacher answered Enjoyable and the other Very Enjoyable. Their comments are as follows:

> No discipline to consider; only concentration on the subject matter; plent of individual instruction; these things made the course enjoyable. The lack of good teacher-class atmosphere would be a drawback, however.

> This course enabled me to give greater individual instruction to the slow student thereby instilling in him a better understanding and confidence in his work.

The next question was: "Do you think this program should be made available for the use of teachers throughout the country?" One teacher answered yes and added the following comment.

> Such a program can be used as a basis for teaching the entire program or part time for enrichment or supplementary to the conventional course.

The other teacher answered the question by indicating he didn't know and added the following comment.

> I still have some reservations about this course. I'm not sure such a course is suitable for everyone, such as: (1) the student that is easily bored (2) the student that daydreams (3) the student that reads poorly.

The final question asked the teachers was to summarize their opinion of the program. One teacher replied as follows:

> Strong Points:
> 1. Perhaps it is unnecessary to point out the obvious strong points.

These are the points for which the course was designed.

- a. The student progresses at an individual rate.
- b. The teacher spends the majority of his time in individual instruction.
- c. The student experiences less error-making.
- d. The student is rewarded or reinforced immediately with the answers.
- e. Active participation on the part of the student.

2. The opportunity for enrichment is much greater in this course if the student finished the course before the end of the term. I have a boy who is taking a course in the slide rule (Tutortext). He would never have this opportunity in the conventional course in algebra.

3. Another strong point about programmed algebra is that due to the fact that algebra is a "basic fact" course of tools and rules for more advanced work, the student can learn these facts and skills quickly so that he can dig into more advanced work sooner.

4. Another strong point which is important to any teacher is that in this course no discipline is needed; and self-motivation is very apparent.

Weak Points:

1. It is very narrow in approach. The student is not exposed to very many types of problems.
2. Students become bored with the constant repetition of process.
3. Teacher-class interaction is missing.
4. Some of the units need revising
   - a. Word problems
   - b. Unit six too long
5. Review for the student is not well handled. It is not extensive enough; only a problem here and there.
6. Students do not learn a neat and accurate form for solving problems. Lack of good form deters problem solving.
7. The testing part of the program needs two tests for each unit--in this way if a student does poorly on the first test, he can, after restudy, take a second equivalent one.

It is my opinion that there should be some type of grouping so that the class could be kept within certain ranges of units. This would allow for weekly discussions of problems and questions that the students request. This, in a sense, partially defeats the individual progress of the student but it does give the teacher a chance to discuss problems in depth, which is lacking in the program. It could serve as a review for the student and also give them the teacher-class atmosphere which they miss.

> This grouping of students might also make it possible to give a test on a given date for all students. The group would be required to finish, say, one, two or three units by a given time and then take the tests together. Following the test, or tests, a period of discussion would clear up errors made and perhaps broaden the course with problems of a similar nature. I can see objections to this suggestion but it does provide for valuable class discussion involving the entire group. (My group has consistently asked for more class discussion.)
>
> It is also my opinion that the machines themselves are most cumbersome at a desk, although they serve a purpose. They force the student to think about the question carefully so that they can remember it before they turn up the next frame.

The other teacher replied to the question as follows:

> As a teacher of algebra for over twelve years, I find the use of programmed instruction a challenge -- challenge in the art of teaching so that students at all levels understands every step in every process along the way. Sometimes in the conventional course this was practically an impossible task what with thirty or more students. It makes assimilation much easier and far more pleasurable to the student when he knows and understands what is being taught. Confidence can be instilled, since he can confirm his answer and if he is wrong he can seek additional help from the teacher to clarify his misunderstanding.
>
> The heart of such a program is a salvation for the average or below average student who would like to enroll in algebra but is afraid that he cannot compete with the student with excellent math ability.

Weak Points:

1. Monotony and boring.
2. The slow learners require more problems, especially, the four fundamentals of polynomials, factoring, operations with algebraic fractions, solution of quadratic and fractional equations, and solution of simultaneous equations. The instructor found it necessary to supplement programmed material with problems from text books to over half the class.
3. Material advances a bit too rapidly in some of the processes.
4. Some of the units rather lengthy. Students experienced recall difficulty.

5. Students should be given longer and more frequent tests throughout the unit rather than at the conclusion of the unit.
6. Some students tended to drift and daydream a lot. This was true during part II of programmed course.

Strong Points:

1. The answer for students who find it necessary to drop from school because of illness.
2. Appropriate for the slow methodical learner.
3. Program similar to conventional procedure.

Cases in support of program.

A student in the experimental class became hospitalized for a short time. Later while confined to his home, the Home Visitation teacher continued his course by means of the teaching machine. The student did very well, completed the course and received a grade of C for the semester.

Another student in the regular algebra class of another teacher found it necessary to withdraw from school the first semester at the end of the second six weeks period because of illness. The student re-entered school the second semester at the beginning of the second six weeks period. The principal inquired as to whether or not the student could continue algebra by the use of the machine. The student was given post unit tests to determine the level of learning thus far attained in algebra I. In four weeks the student completed program I and continued the remainder of the semester on program II completing the course with a grade of C.

The above cases support the value of programmed instruction, otherwise the two students would have failed or received an incomplete.

Suggested to (______________) the Home Visitation teacher, she contact your office for information relative to other programmed courses that could be used in similar circumstances.

CHAPTER V

ANALYSIS OF STUDENT EVALUATIONS

Students in the two experimental sections were asked to complete a questionnaire at the end of the research project (see Appendix F). An open-ended question was included which asked: "In your own words say what you thought of the program. For example, what did you like about the program. What did you dislike about it, etc.?"

With the reservations inherent in evaluating subjective data, a number of general statements concerning the students' answers may be made. It appears that among both ninth and tenth grade students some people felt that they would rather work with textbooks than with the programmed material. Students in both groups also mentioned frequently that they felt the programmed materials became increasingly boring and repetitious as they progressed through the material.

A number of ninth grade students mentioned that they felt they would have done better if they had been given homework, a point not mentioned by any tenth grade student. There were some students in both groups, however, that felt the lack of homework was one of the strong points in favor of programmed teaching methods.

The lack of teacher contact and class discussion was mentioned by a number of students in both groups as being a drawback to the use of teaching machines. At the same time three ninth grade and eleven tenth grade students specifically mentioned that they liked being able to work at their own speed without teacher direction.

Three ninth grade people stated categorically that they would not take another programmed course if they were given their choice. Four ninth grade students' comments were not quite so sharply drawn, but the gist of their remarks indicates they felt the course was not worth the effort. At the same time, however, three ninth grade and one tenth grade student commented that they preferred this type of teaching over the traditional methods used in the system.

The answers to the first six questions are summarized in Table II, page 33. In answer to the first question: "If a program had not been used in this course,...." 78 per cent of the ninth grade students felt that they would have learned more from the course if the programmed material had not been used. Among tenth grade pupils the reaction was not as sharply delineated. However, the general reaction is still that they felt they would have learned more without the material.

In response to question number two: "In comparing work done using the program with studying textbooks, I feel that, with the same amount of time and effort:..." a substantial number of students, 37 per cent of the ninth grade and 46 per cent of the tenth grade people, felt that they could learn more from studying textbooks.

Question number three: If I were to take another course in this subject or a similar field, I would:...." elicited the answer from 59 per cent of the ninth

TABLE II

PERCENTAGE RESULTS OF STUDENTS' EVALUATION

Question	GRADE		
	9	10	Total
1. If a program had not been used in this course, I believe			
I would have learned less from the course	7	12	10
It would have made no difference	15	46	29
I would have learned more from the course	78	42	61
	(N-27)	(N-24)	(N-51)
2. In comparing work done using the program with studying in regular textbooks, I feel that, with the same amount of time and effort:			
I learn much more with the program	11	8	10
I learn somewhat more with the program	26	17	21
I feel there is no difference	4	25	14
I learn somewhat more from studying textbooks	37	46	41
I learn much more from studying textbooks	22	4	14
	(N-27)	(N-24)	(N-51)
3. If I were to take another course in this subject or a similar field, I would:			
Prefer to have programs used for at least part of the course	37	50	43
Prefer not to have programs used	59	25	43
Not care whether programs are used or not	4	25	14
	(N-27)	(N-24)	(N-51)
4. How much do you think you learned from the program?			
Learned nothing	0	0	0
Learned a little	15	8	12
Learned a medium amount	59	46	53
Learned quite a bit	26	33	29
Learned very much	0	13	6
	(N-27)	(N-24)	(N-51)
5. To what extent did you enjoy going through this program?			
Very unenjoyable	0	0	0
Unenjoyable	26	13	20
50-50	56	29	43
Enjoyable	18	50	33
Very Enjoyable	0	8	4
	(N-27)	(N-24)	(N-51)
6. To what extent was the program repetitious?			
Much to repetitious	11	0	6
Too repetitious	15	9	12
Moderately repetitious	52	65	58
Slightly repetitious	18	26	22
Not at all repetitious	4	0	2
	(N-27)	(N-23)	(N-50)

grade students that they would prefer not having the materials used. Fifty per cent of the tenth grade people took the view point that they would prefer having the material used at least part of the time.

The fourth question was: "How much do you think you learned from the program?" Fifty-nine per cent of the ninth grade people and forty-six per cent of the tenth grade students felt that they learned a medium amount from the program.

"To what extent did you enjoy going through this program?" was question number five. Fifty-six per cent of the ninth grade students had ambivalent feelings about the extent to which they enjoyed the material. Among the tenth grade people the response was more positive with fifty per cent of the group indicating that they enjoyed using the programmed material.

The last question: "To what extent was the program repetitious?" produced a clear cut response. Fifty-two per cent of the ninth grade students and sixty-five per cent of the tenth graders felt that the program was moderately repetitious. There is some question as to whether or not the students understood that one of the basic principles of programmed materials is repetition, however. In addition, it is not known from the study if this view relates to repeated material or the size of the steps in the program. It may be that the objection is actually to the size of the steps, but that it is stated as repetition.

To summarize, it appears that the students in the ninth grade experimental group reacted in a generally negative manner to the programmed material. The students in the tenth grade group, in general, appear to be somewhat more positive in their response.

CHAPTER VI

ANALYSIS OF STATISTICAL DATA

In respect to time, the first factor that needs to be considered, both control groups met daily for one class period of 50 minutes for the entire school year. This was not true in the case of the experimental groups. The late arrival of the programmed materials necessitated starting four weeks after the opening of school. Therefore, the control groups studied algebra for 38 weeks using traditional methods and the experimental groups met for 34 weeks for 50 minutes daily.

Table I, page 16, gives a tabulation of the number of students in the experimental groups completing each unit of programmed materials. By studying this table it may be observed that five ninth grade and two tenth grade people finished all 16 units of the course. It may also be observed that one student in each group proceeded no further than Unit 7. In interpreting the latter figure it must be remembered that the students had to repeat work if their post unit test scores were not up to the standard set by their teachers and that they started four weeks late.

Three variables, an intelligence test score, an algebra aptitude test score, and the California Study Methods Survey score were selected for statistical analysis to determine if differences between groups existed at the beginning of the research. In testing the differences between groups, the null hypothesis was assumed, i.e., there is no difference in variation in the means of the samples greater than could be expected due to sample fluctuations.

Table III, page 37, presents the "t" values obtained when the null hypothesis was tested by use of the Otis Intelligence Test scores. Additional data in the form of mean scores and standard deviations for the intelligence test are tabulated in Table IV, page 38.

It can be observed from Table III that the null hypothesis, i.e., there were no differences between experimental and control groups as measured by Otis Intelligence Test scores exist which are greater than those present due to normal sample fluctuations, was found tenable. The exception is as the hypothesis relates to the lower 25 per cent of the tenth grade group. In this case a "t" value that is significant at the 1.0 per cent level and beyond was found. The null hypothesis as it relates to this group is rejected.

Table V, page 39, tabulates the "t" values obtained when the null hypothesis was tested by the Lankton First-Year Algebra test scores. The value of "t" obtained for the test between the ninth grade control and experimental groups is not significant. In this instance the null hypothesis, i.e., there is no difference between the means of the groups as measured by the Lankton test scores, is tenable. For the tenth grade students the comparison of the experimental and control group means on the Lankton test is significant at the 5.0 per cent level of confidence and beyond. The null hypothesis as it relates to these groups is rejected.

TABLE III

A COMPARISON OF "t" VALUES BETWEEN EXPERIMENTAL AND CONTROL GROUP TESTS OF SIGNIFICANCE FOR THE OTIS INTELLIGENCE TEST SCORES

GRADE	Levels of Group (by intelligence) 1. Top 25% 2. Middle 50% 3. Lower 25%	SUBJECTS		"t"	PROBABILITY
		Exp.	Cont.		
9	1	7	7	1.9070	n.s.
	2	13	14	.9291	n.s.
	3	7	7	1.5367	n.s.
	Total	27	28	.2172	n.s.
10	1	6	6	.7895	n.s.
	2	13	11	.5158	n.s.
	3	6	6	4.5139	<.01
	Total	25	23	.5829	n.s.
9&10	1	13	13	1.0918	n.s.
	2	26	25	.4310	n.s.
	3	13	13	.9448	n.s.
	Total	52	51	.2847	n.s.

TABLE IV

A COMPARISON OF MEAN DIFFERENCE OF OTIS INTELLIGENCE TEST SCORES BETWEEN EXPERIMENTAL AND CONTROL GROUPS

GRADE	Levels of Group (by intelligence) 1. Top 25% 2. Middle 50% 3. Lower 25%	SUBJECTS	EXPERIMENTAL		GRADE	Levels of Group (by intelligence) 1. Top 25% 2. Middle 50% 3. Lower 25%	SUBJECTS	CONTROL	
			MEAN	STANDARD DEVIATION				MEAN	STANDARD DEVIATION
9	1	7	117.86	1.45	9	1	7	121.14	3.90
	2	13	111.54	2.59		2	14	110.36	3.77
	3	7	102.86	1.64		3	7	100.14	4.02
	Total	27	110.93	5.83		Total	28	110.50	8.38
10	1	6	113.50	2.22	10	1	6	112.00	3.65
	2	13	105.31	2.67		2	11	104.82	1.75
	3	6	94.67	3.20		3	6	101.17	.37
	Total	25	104.72	7.09		Total	23	105.74	4.59
9 & 10	1	13	115.85	2.85	9 & 10	1	13	116.92	5.94
	2	26	108.42	4.08		2	25	107.92	4.11
	3	13	99.08	4.78		3	13	100.62	3.00
	Total	52	107.94	7.17		Total	51	108.35	7.32

TABLE V

A COMPARISON OF PRE AND PRE AND POST AND POST TEST SCORES ON THE LANKTON FIRST-YEAR ALGEBRA TEST AND THE CALIFORNIA STUDY METHODS SURVEY BETWEEN EXPERIMENTAL AND CONTROL GROUPS

Test	9th GRADE						10th GRADE					
	Control N	Experimental N	Control Mean	Experimental Mean	"t"	Probability	Control N	Experimental N	Control Mean	Experimental Mean	"t"	Probability
nkton												
Pre	28	27	94.86	93.56	.6500	n.s.	22	25	89.14	94.56	2.3262	<.05
Post	28	27	115.64	108.52	2.0698	<05	22	25	103.05	103.32	.1023	n.s.
lif. A												
Pre	28	27	35.50	35.96	.4249	n.s.	23	25	29.35	29.28	.0387	n.s.
Post	28	27	34.32	34.52	.4421	n.s.	23	25	26.86	28.64	2.2714	<.05
lif. B												
Pre	28	27	42.10	42.44	.2171	n.s.	23	25	39.70	37.00	1.5517	n.s.
Post	28	27	41.04	41.89	.5776	n.s.	23	25	38.96	38.24	.3892	n.s.
lif. C												
Pre	28	27	19.82	20.22	.3226	n.s.	23	25	18.22	18.12	.0735	n.s.
Post	28	27	18.50	19.70	1.0811	n.s.	23	25	16.57	16.40	.1298	n.s.
lif. T												
Pre	28	27	97.43	98.63	.6162	n.s.	23	25	87.39	84.40	.7438	n.s.
Post	28	27	93.86	96.11	.5528	n.s.	23	25	82.39	83.28	.2119	n.s.
lif. VF												
Pre	28	27	26.04	25.70	.6182	n.s.	23	25	25.22	25.40	.0677	n.s.
Post	28	27	25.93	26.07	.2545	n.s.	23	25	25.52	25.24	.3636	n.s.

The data for the third variable used to test the differences between groups at the start of the research project, test scores on the California Study Methods Survey, is presented in Table V. The null hypothesis, i.e., that there are no differences between groups as measured by the scores on the California Study Methods Survey greater than present in random sample fluctuations, is found tenable for all groups and for all subtest scores.

The data discussed above indicate that the two ninth grade and two tenth grade groups were equal as to intelligence (except for the lower 25 per cent of the tenth grade group) at the start of the experimental procedure. It further indicates that the aptitudes measured by the Lankton First-Year Algebra test shows the ninth grade groups to be equal in this respect, but that tenth grade groups are not. In addition and without exception it shows that as far as the characteristics measured by the California Study Methods Survey are concerned all subtests and both groups are equal.

In addition to the analysis of the control variables successive "t" tests were also performed for the pre and post test scores on the criterion instruments used to evaluate the experimental conditions. Table VI and VII, pages 41 and 42, tabulate the mean scores and standard deviations for the pre and post Lankton and California tests. Table VIII, page 43, tabulates "t" values and probabilities for the mean differences of these tests. Table IX, page 44, tabulates the per cent of increase in the man scores on the Lankton.

A consideration of Table VII will show that a statistically significant gain in mean scores was found for all groups on the Lankton test with the exception of the top 25 per cent of the tenth grade experimental group. There-

TABLE VI

A COMPARISON OF PRE AND POST TEST MEAN SCORES IN THE LANKTON FIRST-YEAR ALGEBRA TEST AND THE CALIFORNIA STUDY METHODS SURVEY

	GRADE	Level of Group (by intelligence) 1. Top 25% 2. Middle 50% 3. Lower 25%	SUBJECTS	Lankton		California A		California B		California C		California T		California VF	
				Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
EXPERIMENTAL	9	1	7	98.4	115.4	37.9	36.7	44.3	44.4	20.6	19.1	102.7	100.3	25.9	26.6
		2	13	94.2	108.2	34.5	34.0	43.5	44.7	20.6	19.4	98.6	98.1	26.0	25.8
		3	7	87.4	102.3	36.9	33.3	38.6	34.1	19.1	20.9	94.6	88.3	25.1	26.1
		Total	27	93.6	108.5	36.0	34.5	42.4	41.9	20.2	19.7	98.6	96.1	25.7	26.1
	10	1	6	98.8	102.0	27.8	30.5	34.0	38.0	14.7	14.5	76.5	83.0	25.3	24.2
		2	13	94.5	106.5	30.5	28.2	39.9	40.2	20.3	17.1	90.8	85.5	25.2	25.8
		3	6	90.5	97.7	28.0	27.7	33.7	34.2	16.8	16.8	78.5	78.7	24.5	25.2
		Total	25	94.6	103.3	29.3	28.6	37.0	38.2	18.1	16.4	84.4	83.3	25.4	25.2
CONTROL	9	1	7	102.9	127.0	35.0	37.0	48.0	43.9	18.7	15.7	101.7	96.4	26.7	27.0
		2	14	93.9	116.4	38.1	36.4	42.5	42.7	22.4	21.0	102.9	100.1	26.1	26.1
		3	7	88.9	102.9	30.9	27.6	35.4	35.0	15.9	16.3	82.1	78.9	25.1	24.4
		Total	28	94.9	115.6	35.5	34.3	42.1	41.0	19.8	18.5	97.4	93.9	26.0	25.9
	10	1	6	91.0	108.5	32.2	27.0	44.5	43.0	18.2	16.7	95.3	86.7	26.7	27.0
		2	11	89.8*	102.4*	28.0	25.2	37.2	35.3	18.6	16.5	83.7	76.9	24.0	25.1
		3	6	86.2	98.7	29.0	29.8	39.5	41.7	17.7	16.7	86.2	88.2	26.0	24.8
		Total	23	89.1	103.1	29.4	26.9	39.7	39.0	18.2	16.6	87.4	82.4	25.2	25.5

*N for these values is 10 instead of 11 as is the case in all parts of the California for group 2.

TABLE VII

A COMPARISON OF PRE AND POST TEST STANDARD DEVIATIONS ON THE LANKTON FIRST YEAR ALGEBRA TEST AND THE CALIFORNIA STUDY METHODS SURVEY

	GRADE	Level of Group (by intelligence) 1. Top 25% 2. Middle 50% 3. Lower 25%	SUBJECTS	Lankton		California A		California B		California C		California T		California VF	
				Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
EXPERIMENTAL	9	1	7	3.0	8.8	3.5	7.7	3.9	2.4	4.4	4.5	10.8	10.5	1.9	1.7
		2	13	8.3	14.3	6.3	7.1	5.7	5.5	4.4	5.1	14.6	15.0	1.3	2.4
		3	7	1.6	6.0	2.9	5.0	4.2	10.8	3.2	5.9	8.3	11.0	2.5	1.6
		Total	27	7.6	12.3	5.2	6.9	5.4	8.2	4.2	5.2	12.6	13.8	1.9	2.1
	10	1	6	6.3	5.1	4.7	3.3	7.6	7.2	5.2	2.9	16.5	13.0	2.1	3.4
		2	13	8.7	10.8	6.8	5.5	4.6	6.2	3.7	4.1	3.9	4.0	1.6	2.4
		3	6	9.9	10.3	6.2	4.5	3.5	6.9	4.3	3.5	11.2	10.5	2.1	2.7
		Total	25	9.0	10.1	6.3	4.9	6.1	7.1	4.9	3.9	14.7	12.6	1.9	2.8
CONTROL	9	1	7	4.4	6.8	3.8	8.1	3.2	3.6	3.8	3.1	5.8	12.2	1.8	1.1
		2	14	5.1	11.8	4.6	4.9	4.2	4.6	4.1	5.2	11.5	13.6	2.0	1.6
		3	7	4.2	5.9	5.5	7.9	3.4	4.5	3.6	4.8	10.5	14.4	2.4	2.3
		Total	28	6.9	12.8	5.5	7.3	5.8	5.6	4.8	5.3	13.4	15.8	2.2	1.9
	10	1	6	7.2	8.7	3.5	7.3	1.3	3.0	5.5	5.6	9.4	4.4	.94	1.0
		2	11	10.3*	6.1*	7.5	9.2	6.4	5.1	4.0	4.8	14.4	15.7	3.0	3.0
		3	6	7.8	3.5	2.9	8.1	3.5	3.0	3.4	4.4	6.4	13.3	1.4	1.6
		Total	23	9.1	7.4	5.9	8.7	5.7	5.4	4.3	4.9	12.5	15.6	2.5	2.4

*N for these values is 10 instead of 11 as is the case in all parts of the California for group 2.

TABLE VIII

A COMPARISON OF MEAN DIFFERENCES OF PRE AND POST TEST SCORES ON THE LANKTON FIRST-YEAR ALGEBRA TEST AND THE CALIFORNIA STUDY METHODS SURVEY FOR EXPERIMENTAL AND CONTROL GROUPS

	GRADE	Level of Group (by intelligence) 1. Top 25% 2. Middle 50% 3. Lower 25%	SUBJECTS	"t" Lankton	"t" Calif. A	"t" Calif. B	"t" Calif. C	"t" Calif. T	"t" Calif. VF	PROBABILITY Lankton	PROBABILITY Calif. A	PROBABILITY Calif. B	PROBABILITY Calif. C	PROBABILITY Calif. T	PROBABILITY Calif. VF
EXPERIMENTAL	9	1	7	6.5385	.3529	.0921	1.1085	.5971	.6454	<.001	n.s.	n.s.	n.s.	n.s.	n.s.
		2	13	3.6156	.4554	1.4024	1.0513	.2714	.1875	<.01	n.s.	n.s.	n.s.	n.s.	n.s.
		3	7	8.3483	1.8214	1.1301	.4831	1.4562	1.5385	<.001	n.s.	n.s.	n.s.	n.s.	n.s.
		Total	27	7.4059	1.3458	.4667	.4727	1.4078	.7400	<.001	n.s.	n.s.	n.s.	n.s.	n.s.
	10	1	6	1.0000	2.8105	5.7971	.1104	3.0373	1.0263	n.s.	.05	<.01	n.s.	<.05	n.s.
		2	13	5.4170	1.7239	.1103	3.1058	1.9170	.1290	<.001	n.s.	n.s.	<.01	n.s.	n.s.
		3	6	3.2110	.2063	.2463	.0000	.0373	.4558	<.05	n.s.	n.s.	n.s.	n.s.	n.s.
		Total	25	5.4161	.8750	1.3778	2.2933	.6073	.2963	<.001	n.s.	n.s.	n.s.	n.s.	n.s.
CONTROL	9	1	7	8.7782	.8130	2.0526	1.4151	1.3044	.4531	<.001	n.s.	n.s.	n.s.	n.s.	n.s.
		2	14	7.7055	1.5688	.1765	1.7000	1.4372	.2917	<.001	n.s.	n.s.	n.s.	n.s.	n.s.
		3	7	6.8293	1.8380	.3116	.3162	.9734	.7030	<.001	n.s.	n.s.	n.s.	n.s.	n.s.
		Total	28	11.4231	1.1919	1.1758	1.7600	2.2331	.4865	<.001	n.s.	n.s.	n.s.	n.s.	n.s.
	10	1	6	6.4103	2.3798	.9615	.5435	1.2457	.8500	<.01	n.s.	n.s.	n.s.	n.s.	n.s.
		2	11	5.0644*	1.7962	1.5748	.8310	2.9397	1.0085	<.001	n.s.	n.s.	n.s.	n.s.	n.s.
		3	6	2.7412	.3294	1.5500	.4950	.2714	1.6714	<.05	n.s.	n.s.	n.s.	n.s.	n.s.
		Total	23	7.2460	2.6378	.9070	1.1509	2.4357	.5645	<.001	n.s.	n.s.	n.s.	n.s.	n.s.

(At 5 df a "t" value of 2.571 is required for p <.05, 4.032 is required for p <.01, and 6.859 at p <.001. At 10 df a "t" value of 2.228 is required for p <.05, 3.169 for p <.01, and 4.587 at p <.001. All indicated "t" values are differences between pre and post test scores for group and test shown.)

*N for these values is 10 instead of 11 as is the case in all parts of the California for group 2.

TABLE IX

PER CENT OF MEAN SCORE GAIN ON THE LANKTON TEST FROM PRE TO POST TEST MEASUREMENT

	GRADE	Level of Group (by intelligence) 1. Top 25% 2. Middle 50% 3. Lower 25%	$\overline{X}$ Pre	$\overline{X}$ Post	Gain	Per Cent
EXPERIMENTAL	9	1	98.4	115.4	7.0	7
		2	94.2	108.2	14.0	15
		3	87.4	102.3	14.9	17
		Total	93.6	108.5	15.1	16
	10	1	98.8	102.0	3.2	3
		2	94.5	106.5	12.0	13
		3	90.5	97.7	7.2	8
		Total	94.6	103.3	8.7	9
CONTROL	9	1	102.9	127.0	24.1	23
		2	93.9	116.4	22.5	24
		3	88.9	102.9	14.0	14
		Total	94.9	115.6	20.7	22
	10	1	91.0	108.5	17.5	19
		2	89.8	102.4	12.6	14
		3	86.2	98.7	11.5	13
		Total	89.1	103.1	14.0	16

fore, with the exception noted, the null hypothesis, i.e., there are no differences between groups as measured by the Lankton First-Year Algebra test are shown that cannot be attributed to random sample fluctuation, is rejected.

Apprasial of the data presented in Table VIII will show that without exception no significant gain in mean scores was found in the characteristics measured by the California test for either the ninth or tenth grade control groups. Further, no statistically significant gain is shown for the ninth grade experimental class or lower 25 per cent of the tenth grade experimental group. Therefore, the null hypothesis, i.e., no difference exists as measured by the California Study Methods Survey for these groups, is found tenable.

Consideration of Table VI and VIII does show, however, that a statistically significant gain on the California test was found in sub tests A, B, and T for the top 25 per cent of the tenth grade experimental group. There is also a statistically significant loss for the mean score of part C, for the middle 50 per cent of the tenth grade experimental group. The null hypothesis as it relates to these groups is rejected.

Sub-test A of the California test measures the student's attitude toward school as it relates to his feelings of harmony with the school-community and his moral. In sub test B an attempt is made to measure the student's attitudes as they relate to mechanics of study. In this instance consideration is given to the student's feelings about the use of outlines in reading or note taking, memorization, reviewing for tests, differential approaches to learning new subject matter, and techniques used for retention of various subjects.

The student's attitudes relating to planning and system are investigated in sub-test C. Here the test items attempt to measure the student's feelings as they relate to his estimate of the extent to which he budgets his time and the degree of care he exercises in performing his academic tasks.

It will be recalled that in sub-test C for the middle 50 per cent of the tenth grade experimental group, the only statistically significant loss in the differences between means was found. It is, of course, quite impossible to state an exact reason for this loss. However, a tentative hypothesis may be advanced.

It will be remembered that the tenth grade experimental and control groups are made up of students who previously failed ninth grade algebra or who elected to take general math in the ninth and algebra in the tenth grade, a year later than usual. From past performance it is then reasonable to surmise that this middle 50 per cent had an estimate of their ability that was at variance with the typical ninth grade school population.

From the pre test mean of this group as compared to the post test mean, it appears that they had a rather high estimate of their ability to plan and systematically deal with academic skills as measured by the California test. On completion of the highly systematic approach to algebra taken by the programmed materials, it is possible then, that they may have revised their opinion of their own abilities along these lines. If so, this is one hypothesis that would account for the significant loss shown by the post test mean for this sub test.

In summary, the statistical data indicates that with the exception of the lower 25 per cent of the tenth grade experimental group all groups of both the ninth and tenth grade students made statistically significant gains in the mean scores on the Lankton First-Year Algebra test. The data also indicates that no gains on the California Study Methods Survey were found for the following groups: all control groups both ninth and tenth grade, all students in the ninth grade experimental groups, and the lower 25 per cent group of tenth grade experimental students. Further, the data shows that a statistically significant gain was made by the top 25 per cent of the tenth grade experimental group in sub-tests A, B and in total score on the California Study Methods Survey. Finally the data indicates a statistically significant loss in mean score value for the middle 50 per cent of the tenth grade experimental group on sub-test C of the California test.

CHAPTER VII

CONCLUSIONS

The purpose of this research project was to determine the effectiveness of programmed materials and teaching machines in teaching algebra to ninth and tenth grade students. In order to do this two schools were selected to supply one experimental and one control group each. The experimental group used programmed materials and teaching machines, and the control group used the conventional methods and materials used in teaching algebra in the regular classrooms of the school system.

A descriptive analysis of the program was made through the use of teachers' and students' reports and evaluations. Tests of statistical significance were made to test the gain made by each group. These tests were made by total groups and by ability groups as determined by intelligence test scores.

Following are some of the conclusions reached as a result of this study:

1. Students in both groups felt that the programmed materials became increasingly boring and repetitious as they progressed through the course.
2. Students in both groups felt that they would have learned some-

what more from the use of textbooks than they did by use of the programmed materials.

3. Students in both groups felt that not having homework was a positive factor, however, some ninth grade people felt that they would have done better if they had been given homework.
4. Students in both groups felt the lack of teacher contact in the traditional classroom sense was a drawback to the programmed teaching procedure. At the same time, however, three ninth grade and eleven tenth grade students made positive statements of feeling about being able to work at their own speed without teacher direction.
5. Teachers felt that the level of difficulty of the programmed algebra material was appropriate for their group.
6. Teachers said that they felt that with the use of programmed materials it was quite easy to handle make-up work required by student absences. One student, in fact, found it possible to complete the course after the close of the school year in the spring.
7. Teachers felt that the use of programmed materials eliminated virtually all concern with classroom discipline and in fact the classrooms were too quiet.
8. Teachers felt that the lack of traditional classroom give and take between teacher and class was a negative aspect in the use of programmed materials. They did comment favorably, however, on the additional amount of time using the materials provided for

assisting individual students with problems. Apparently more time is available with the use of programmed materials than is usual in a classroom employing traditional methods of teaching for individual help.

9. Despite reserved opinions on many points both teachers felt that in general using the teaching machines and programmed materials was an enjoyable experience.
10. The teacher of the tenth grade group indicated a preference for using programmed materials to teach the entire course in future years. The teacher of the ninth grade group indicated that more experience with the material was needed before an opinion could be expressed.
11. Teachers indicated students began work at the start of the year with a high degree of motivation which deteriorated somewhat as the year progressed, but which continued at an excellent level throughout the second semester even so.
12. One teacher found it possible to provide for individual differences by use of programmed materials. One student in the ninth grade experimental section completed the course before the end of the term. He was then able to take a second programmed course on the slide rule before the end of the year.
13. Some fear has been expressed that teaching machines would replace teachers. This fear should have been dispelled after this project was completed. It appears that the teacher's work load was increased

as a result of the use of programmed materials.

Based on the statistical data, it is not possible to make a single definitive statement that one method of teaching is clearly superior to the other. It does appear, however, that the following conclusions may be reached:

14. There was a significant gain in mean scores for the top 25 per cent of the tenth grade experimental group on the Attitudes Toward School portion of the California Study Methods Survey.
15. There was a significant gain in mean scores for the top 25 per cent of the tenth grade experimental group on the Mechanics of Study portion of the California Study Methods Survey.
16. There was a significant gain in the mean score for the top 25 per cent of the tenth grade experimental group on the total score of the California Study Methods Survey.
17. There was a significant loss in the mean score for the middle 50 per cent of the tenth grade experimental group on the Planning and System portion of the California Study Methods Survey.
18. There was a significant gain in the mean score for all groups, both experimental and control, on the Lankton First-Year Algebra Test with the exception of the top 25 per cent of the tenth grade experimental group.
19. There were no significant changes in mean score either gain or loss for any subtest or total score for the control groups on the California Study Methods Survey.

As a result of this study the following recommendations are made:

1. That further studies be made relative to the use of programmed materials and teaching machines in the local school system.
2. That programmed materials be considered as a device for strengthening the curriculum, especially at advance levels.
3. That research be conducted to further evaluate the effectiveness of programmed materials in the teaching of algebra to tenth grade students. Eleven students out of 25 in the experimental group indicated a clearly positive reaction to the use of the materials, but with the reservation that the continued use of the materials was boring and repetitious. Such a study should consider this point in its experimental design.
4. That as time permits, the following extension of the study should be made: test students the following year for retention, determine "novelty effect" of the programmed materials by use of first and second half test techniques in any subsequent study of programmed materials.
5. That research studies be continued in the local school system. Research studies that are designed and controlled appropriately tend to motivate students and teachers alike.

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APPENDIX

APPENDIX A

LETTER TO PARENTS AND INFORMATION ON TEACHING MACHINES AND PROGRAMMED INSTRUCTION

September 1962

Dear Parents:

The purpose of this letter is to inform parents that their child will be studying algebra this year in a somewhat different manner than in previous years.

Attached to this letter is a bulletin discussing teaching machines and programmed learning. It has been prepared by The Center for Programmed Instruction Inc., in New York City.

Your child is in a class in which programmed materials and teaching machines will be used during the coming school year. The purpose of the attached bulletin is to give you an understanding of programmed materials and teaching machines.

The programmed materials and teaching machines will be used approximately fifty (50) minutes per day for the instruction of algebra. Students will be tested at regular intervals to assure that the material is being learned in an effective manner.

If you should have any questions regarding this special instruction, please feel free to contact your child's classroom teacher, Dr. O'Hare in the Superintendent's Office, or myself.

Sincerely,

__________, Principal

APPENDIX A (continued)

LETTER TO PARENTS AND INFORMATION ON TEACHING MACHINES AND PROGRAMMED INSTRUCTION

A PARENTS GUIDE TO TEACHING MACHINES AND PROGRAMMED INSTRUCTION

Prepared and Published by The
Information Division of
THE CENTER FOR PROGRAMMED INSTRUCTION, INC.

Purpose of the pamphlet:

This pamphlet is intended to help parents interested in utilizing teaching machines and/or programed instructional materials to further their children's education. Most parents have read about teaching machines and programs in magazines or newspapers. The effect of instruction by means of these devices is often impressive, and parents are interested in their possibilities for home study. In addition, many programs and teaching machines are being "offered for sale" in supermarkets, by door to door salesmen, and elsewhere by direct mail, newspaper and magazine advertising. The huge number of requests for information and advice received by the Center indicates that many parents are interested in using these materials and would like guidance as to which programs would be appropriate and for what purposes. It is hoped that this pamphlet will help solve some of the problems which you, the parent, will face.

What is a "program" of instruction?

A "program", as a glossary term for a specialized means of instruction, is a sequence of carefully constructed items or frames leading the student to mastery of a subject with a minimal error. Information is given to the student in small units to which he responds in some way--by completing a sentence, working a problem, or answering a question, and at each step he receives immediate confirmation of his response. Items are designed so that the student can make correct responses while progressing toward more and more complex material and ultimately building the conceptual framework of a subject area. The principles of programing come to us from basic psychological research dealing with the learning process. The "program" should be thought of as a more efficient and effective book, always enhanced by the implementation of a good teacher--and not another "plan" or audio-visual "gimmick."

APPENDIX A (continued)

Is a Teaching Machine Necessary?

A teaching machine has been likened to the binding of a book. Therefore, if a child learns anything, he will learn as a result of the material in a teaching machine (i.e. the program) rather than a result of the teaching machine itself. The machine in actuality has very little to do with the process, and is in many cases unnecessary. Most programs which can be presented by teaching machines can also be presented in a special type of book. Over 90% of the programs presently available for use are published as programed textbooks.

The evidence compiled to date seems to indicate that there is essentially no difference in the learning that takes place between the presentation of a program in a teaching machine and its presentation in a programed textbook. Seven independent research studies have shown no differences between those two methods of presenting a program. Hence, the important thing to get for the child is the program and not necessarily the teaching machine. An up-to-date compendium, with pictures, of available teaching machines may be found in the Finn-Perrin, Teaching Machines and Programed Learning, 1962: A Survey of the Industry. This publication is available from the National Education Association, Washington, D. C.

The Effectiveness of Programed Instruction:

Several experiments using programs have reported very impressive results. There is no doubt that many students can learn a great deal independently with good programs. Unfortunately, not all programs are of equal quality, and there are programs in existence which have not been able to teach anybody anything. It is also unfortunate that several of the producers of teaching machines and programs have resorted to deceptive, sensational advertising. In some cases, advertisements have described very effective, impressive results obtained with a program, and this is accurate, but the situation which produced these results was one which did not even utilize the programs or teaching machines which are being offered by the advertisement.

Thus some producers are giving the impression that it was their material which produced these results when in point of fact it may have been the material of another company. In some instances, producers have gone so far as to inaccurately or incompletely report the effect of a program, and as a result make it look much better than it is.

Even if one has a good quality program, this does not necessarily mean that all children will learn from it. There are, unfortunately, some children who have difficulty learning in school. In addition, most of the programs available today require the student to read. Children who have serious reading difficulties probably will not even be able to read through the program. Programed instruction does not promise miracles, contrary to what some producers seem to be claiming. In general, we have found that success on a program is highly correlated with school success and intelligence. This means that children who do well in school will tend to learn more from a program than students who are not doing as well. Programs can help, in many cases a great deal, but education of a child is a complicated process involving hundreds of problems, and programed instruction like anything else cannot solve all of these in one moment.

Use of Programed Instruction:

Programed instruction is being used by many schools throughout the country to help in the extremely important job of educating our children. Research evidence so far shows that children can learn from programs just as effectively at home in an "unsupervised situation" as they can at school. Naturally, programs do not teach all of the things that are important for our children to learn, and a great deal of school time is required for this, but the experimental evidence gathered to date on the use of programs in the home is very encouraging. It seems feasible and sensible to enrich a child's education through experience with programs at home. In some cases programs may be used with the intention of helping a boy or girl who is slightly behind in his work to "catch up." In other cases, programs may be used with youngsters who are doing well in school to help further their education.

The Availability of Programs:

Programs are available from many sources. The most common sources that the parent would come into contact with would be the door to door salesman, the supermarket, and periodical and newspaper advertising. Many, if not most of the programs which are being used in school are available through the typical producers of instructional materials. In general, these organizations do not place newspaper advertising, market their products through supermarkets, or have a force of door to door salesmen.

Do not necessarily purchase the first program or machine which is offered to you. Programs vary in quality, some being very good and others being extremely poor. One must exercise as much care in the purchasing of programs as one would in the purchasing of food in a supermarket. While some foods are very palatable, others are only digestible, and some will cause trouble. There are several steps we would recommend before purchasing a program or a teaching machine.

Suggested Steps for Parents:

If a salesman has approached you with respect to buying a particular program, or you are interested in a program because you have seen it in a bookstore or supermarket or read an advertisement, we would suggest that you write down

APPENDIX A (continued)

the name of the program and the publisher and take it along with this leaflet to your child's teacher or guidance counselor. The professional school personnel can look up the program in Programs '62: A Guide to Programed Instructional Materials published by the U. S. Office of Education and check to see whether or not the program you are considering teaches material similar to what your child is learning in school. In the United States each school system determines to a great extent its own curriculum. Not all school systems teach the same thing and the approaches to different subject may vary considerably from school to school. It is extremely important that the content and approach of the program you are considering are consistent with the objectives of the school that your child attends.

Two contradictory approaches (one in school and the other at home with a program) can confuse your child, and, rather than help him, you may hinder his efforts. For example, a science program for the fifth grade may teach all about the human body. The school, on the other hand, might be teaching their fifth graders all about atomic structure and both might have the labels of "fifth-grade science." Your child's teacher or guidance counselor is in the best position to know whether or not the particular program you are interested in may help your youngster, for they know the objectives of the school.

If you are interested in using programs of instruction for your children, but have not seen any programs in particular, consult the school personnel and ask them to look in the Guide to Programed Instructional Materials and recommend a program which teaches the kind of thing that would be helpful for your child. Then you may obtain the program from the publisher directly.

There is always the possibility at this time that there is no program for your child's grade level in a particular subject. More programs are being written every day, and hopefully, one will soon become available. A program of high quality, which is consistent with the approach and content which your child is learning in school, can make a valuable contribution to his education for the challenging years which lie ahead.

Questions to ask:

1. What does this program teach?
2. How do I use it?
3. How long should my child work at one time?
4. Should he enlist outside help?
5. How do I know what he is learning or how well he is doing?

APPENDIX A (continued)

The Center for Programed Instruction, Inc., a non-profit educational organization, was established in December of 1960, with the help of a grant from the Carnegie Corporation of New York. It is dedicated to the research and development of the principles of programing as well as the collection and dissemination of information concerning the utilization of programed instructional materials. The major objective of the Center is to translate research findings into practical classroom application, primarily at the elementary and secondary levels.

APPENDIX B

PRE TESTING SCHEDULE

ALGEBRA EXPERIMENT - GRADES 9 & 10

Schools: Washington Senior High and Edison Junior High

EVALUATION SCHEDULE

NAME OF INSTRUMENT	GROUP TO BE TESTED	BY WHOM	WHEN
California Study Methods Survey	Control and Experimental 9 and 10	Classroom Teacher	Before Sept. 17
Lankton First-Year Algebra Test	Control and Experimental 9 and 10	Classroom Teacher	Before Sept. 17
Otis Gamma Intelligence Test	Control and Experimental 9 and 10	Classroom Teacher	Sept. 17 until the end of the year
Students' Time Log and Commentary	Experimental Only	Students	Sept. 17 until the end of the year
Teachers' Anecdotal Records	Experimental Only	Classroom Teacher	Sept. 17 until the end of the year

APPENDIX B (continued)

POST TESTING SCHEDULE

Schools: Washington Senior High and Edison Junior High

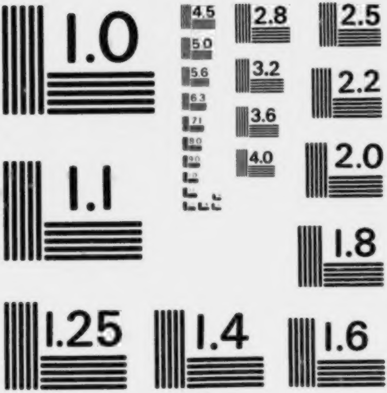
EVALUATION SCHEDULE

NAME OF INSTRUMENT	GROUP TO BE TESTED	BY WHOM	WHEN
Algebra Test Based on Programmed Materials	Experimental 9 and 10	Classroom Teacher	As each student completes each unit
California Study Methods Survey	Control and Experimental 9 and 10	Classroom Teacher	Last week of school year
Lankton First-Year Algebra Test	Control and Experimental 9 and 10	Classroom Teacher	Last week of school year
Students' Time Log and Commentary	Experimental 9 and 10	Students	Send to Dr. O'Hare prior to end of school
Students' Evaluation Sheet	Control and Experimental 9 and 10	Students	Send to Dr. O'Hare prior to end of school
Teachers' Anecdotal Log and Commentary	Experimental 9 and 10	Classroom Teacher	Send to Dr. O'Hare prior to end of school

INSTRUCTIONS

1. Avoid bending corners or folding program sheets.
2. Before inserting unit into machine double check to be sure pages are in proper order.
3. Insert only one unit at a time.
4. Remember to turn unit over after finishing the front side.
5. Keep check on frame numbers so that two sheets don't creep through.
6. Be sure the last sheet is completely through the machine before inserting new unit.
7. Close top before removing a unit from machine. The top will have to be lifted slightly to let the sheets come out. (With the top open the hinges may rip loose.)
8. Use both hands when opening and closing top.
9. Be careful about turning too far and overshooting frame. You can't back it up!
10. You may need some scratch paper to work problems.
11. At the beginning of the period take five minutes or so to review what you covered the day before.
12. Be careful about speeding too fast!! Think about what you are learning.
13. REMEMBER YOU ARE NOT COMPETING WITH YOUR NEIGHBOR. DON'T TRY TO KEEP UP WITH HIM -- KEEP UP WITH YOURSELF.
14. There are errors in the following frames:
    a. Part I Frame 86 page 4 - 18
    b. Part I Frame 4 page 5 - 1
    c. Part II Frame 26 page 7 - 6

DON'T FORGET TO MAKE OUT THE STUDENT'S DAILY LOG!!!
(Leave the log sheet in your machine when you leave.)


1.0
4.5
5.0
5.6
6.3
7.1
8.0
9.0
2.8
3.2
3.6
4.0
2.5
2.2
2.0
1.8
1.1
1.25
1.4
1.6

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

APPENDIX C (continued)

STUDENT TIME LOG

Name________________________________
(last) (first)

School______________________________

STUDENT DAILY TIME LOG

DATE	UNIT	COMPLETED PROBLEMS	Class Periods	Test Score
Sept. 11	1	1 - 60	1	
Sept. 12	1	61 - 199	1	
Sept. 13	1	101 - 143	1/2	
	Unit Test		1/2	12 out of 20
Sept. 14	11	1 - 35	1	
Sept. 17	Absent		0	
Sept. 18	No class (assembly)		0	
Sept. 19	11	36 - 85	1	

Example

APPENDIX D

ALGEBRA--PROGRAMMED LEARNING AND TEACHING MACHINES

Guidelines for Observation of Students for Anecdotal Records

I. Motivation

- A. Positive--which type? (more able, low intelligence, personality types? works on own initiative or needs to be encouraged)
- B. Negative--which type? (More able, low intelligence, personality type?)

II. Behavior Characteristics

- A. Calm and relaxed or nervous and anxious (How does reaction here compare with regular reaction?)
- B. Persistent or gives up easily
- C. Sincere or races through just to finish
- D. Depressed or highly interested
- E. Cooperative or negative or fearful
- F. Overactive or underactive
- G. Attention
  - 1. Concentrated, absorbed by the task
  - 2. Normal attention to outside distractions but returns to task
  - 3. Easily distracted
  - 4. Day-dreams
  - 5. Difficult to hold attention for more than a few seconds

III. Causes of errors

- A. Lack of mastery of arithmetical combinations in adding, subtracting, multiplying, and dividing
- B. Weakness in understanding and use of symbols
- C. Weakness in translating verbal statements into algebraic expressions
- D. Faulty understanding of the number line
- E. Errors in order of fundamental operations
- F. Weakness in specialized mathematics vocabulary
- G. Poor visualization of geometric figures
- H. Low reading comprehension
- I. Weakness in using estimation to check reasonableness of answers
- J. Weakness in seeing relationships in comparisons
- K. Poor handwriting
- L. Poor form in solving problems

IV. Actual comments by pupils

APPENDIX D (continued)

TEACHER'S ANECDOTAL RECORD

PROGRAMMED LEARNING EXPERIMENT

Name of Teacher: ______________________________

School:______________________________ **Grade:**______________

Programmed Course:______________________________

APPENDIX D (continued)

Date: ______________

Remarks:

Date: ______________

Remarks:

Date: ______________

Remarks:

Date: ______________

Remarks:

Date: ______________

Remarks:

APPENDIX D (continued)

ALGEBRA - 9th Grade

9/17/62 The class was asked orally as a group how many were going to college, or how many planned to go to college. All 29 indicated they were going or planned to go to college.

10/2/62 The machines were put into use today. The students have been forced to wait for four weeks until the machines arrived.

They were spending their time learning base 2 and base 5 numbering systems. During this time they were exposed to no algebra.

10/3/62 The machines (some) were temperamental and considerable time was spent in removing sheets which had jammed. I have discovered that one student (from Leopoldville, Congo) has been tutored in algebra before. He wanted to take it over in this country to be sure he's ready for more math later on.

One machine jammed and ruined the first two sheets of Unit 1 for (__________). These will have to be replaced by ditto copy. (__________) had a machine that refused to feed. These two accomplished nothing this period. Both machines have been replaced.

10/4/62 Spent most of the hour with various machines--getting them to work, if possible. Two students at the end of the period were ready to take Unit 1 test. Deferred them until tomorrow.

10/5/62 Some new unit replacements were available. Dr. O'Hare was present and replaced several units for the students. 19 students took the test for Unit 1 today.

10/8/62 New inside units arrived and are gradually being installed. All students have finished the test on Unit 1. Gradually the students are separating as to where they are working in the program. No one has started Unit 3 at this time.

10/9/62 (________)seems to have a weakness. It may be in reading or it may be in math ability altho her numerical ability in the DAT is 61 and verbal reasoning 45. I'll keep watching her. It may be a weakness in seeing relationships in comparisons.

10/10/62 It would be nice if the answer mate could be attached to either side for left-handed persons.

10/15/62 Tried giving some pre-tests before the student started the Unit. I find that all my time is taken during the hour passing out tests and correcting them. (_______)showing some weak work but haven't discovered the reason

APPENDIX D (continued)

ALGEBRA - 9th Grade

yet. (________)asked for help (3x = 18). Referred her to an Algebra text with a series of such problems.

10/16/62 Spent all hour giving out tests and correcting them. As of today everyone has finished Unit 2 tests.

10/17/62 (________)has repeated Unit 3 twice but is still having trouble. Plan to give her some textbook work on the side. I'm of the opinion her trouble is lack of mastery of arithmetical combinations in adding, subtraction, multiplication, and division.

10/18/62 (________) asked for extra work in solving equations of ($\frac{x}{3} = 9$) this kind. Referred him to a text. Still the majority of my time is spent in giving out tests and correcting them.

10/23/62 One student, working on Unit 5, finished his tape roll in the answer mate. It seems that things are calming down. Students are more spread out. I seem to have more time to contact the students thru observation. (Had a visiting teacher today.)

10/24/62 (________) asked for a text today to review solving simple equations. Worked out two sheets full (see folder) and submitted them. I have a feeling of little contact with my students in this course.

10/25/62 Today we took the tape out of the gears of the answer mate. We now pull it through by hand. This not only saves a lot of tape but the room is much more quiet.

10/29/62 For some reason problem 5 in test Unit 5 was missed by the majority of students taking the test. It seems well explained in the program.

10/30/62 Tomorrow we will not work on the programs. Instead we will have an hour of discussion on any questions the students have on equations, terms, parenthesis, etc.

10/31/62 The students, today, asked questions on areas they felt they were weak in algebra. We spent the entire hour reviewing equations, operations, etc. The students reaction to this was that they felt it had value and wanted to continue it. At this point all students, but one, have finished unit B. All questions were limited to the first 5 units. We plan to hold another session following unit 7 (signed numbers). I will try to make sure at this time that everyone understands the rules of signed numbers and their application.

APPENDIX D (continued)

ALGEBRA - 9th Grade

11/2/62 More students are asking to use books to supplement the work on the programmed material. In all cases they want to have more practice in solving various types of equations. I think when we get thru unit 7 (signed numbers) the work on equations will become easier.

11/5/62 Everything very calm. One girl found a printing mistake (unit 7, frame 152).

11/6/62 (________)seems to be preoccupied about something. She is on unit 6, however, and doing average work. It may be nothing.

11/8/62 My students at this point are spread from unit 6 to unit 9. This being the 9th week of school, grades must be averaged. These students have only been working 5 weeks on the course.

11/9/62 It is my opinion that there is a slight feeling of pressure on the part of those students that are not keeping up with the rest. (________)in particular, I believe, is "keeping up with the Joneses" rather than keeping up with herself.

11/13/62 (________)working on unit 11 (first box) is leading the group. He seems very relaxed while working. The conselor tells me he is interested in engineering. One would assume he has a very positive motivation as he plans to go into engineering.

11/14/62 More and more students are reverting to text books for practice. It would seem that they feel the need of working more problems than are provided by the program.

11/19/62 Unit 6 seems to be the most difficult unit. Every student but 3 out of 26 has 7 or less right; 6 have 3 right or less. This is much lower than the average before. This unit is not as clear as the rest.

11/20/62 No class today (tests).

11/21/62 Today (________)asked if she could transfer to General Math. She received a D for a grade (9 weeks). She is rather nervous and tense. We have decided to work together during my free period to see if we can't pull up her understanding.

11/26/62 I made out a short test for Box 2, unit 1 (the number system) as there are no tests for the second unit. When the tests arrive I will give the new one and record it.

APPENDIX D (continued)

ALGEBRA - 9th Grade

11/27/62 Also made out tests for unit 2 and unit 3 (part 2). Probably not the same type as the program uses but an attempt has been made to make them similar.

11/28/62 I think some of the students (the better ones) are a little bored with unit 7. Nothing serious. I am planning another hour of discussion as soon as everyone has finished unit 7. (signed numbers).

11/29/62 Today I stopped the entire class and gave them a sheet of paper. On this paper they were asked to criticize the course (pro and con). No signatures were required. This was not done scientifically nor were questions asked of them. The sheets, as returned, are enclosed in the back of this book. The main criticism was they became bored.

11/30/62 Due to the remarks from yesterday I told the students to leave the machines today. I split the group in half and sent them to the board alternately. We worked (1) equations of the type studied thru unit 6, (2) removing parentheses preceded by plus or minus signs. The reaction to this type of work was very favorable. I plan to repeat this process again, or one similar to it.

12/3/62 At this point I have constructed 4 tests for the first 4 units of part II. I have one student on the 3rd unit of part II.

12/4/62 I think that some algebra problems should be mimeographed on separate sheets of various types. These should be graduated levels of problems. When students finish certain areas or units these challenges could be given to them to help confirm their knowledge of the particular subject matter being studied.

12/6/62 (______)is still having trouble. She doesn't seem to be able to keep sentence thoughts straight in math. She reads sum or add but quite often will multiply. She knows the difference between the two but tries so hard that she forgets the pattern (or sumthin!!!).

12/10/62 A roll of Scotch "magic" tape repairs easily the papers that sometimes are torn in the machines. Once in a while a set of papers go backward through the gears from underneath and are torn.

12/12/62 A mistake in Test Answer frame 198, unit 11 has been found Not the program frame but the test frame answers - "a" should = +1 not a -1.

Things seem very calm. I'm not sure whether it is boredom or just plain algebra that doesn't cause much trouble.

APPENDIX D (continued)

ALGEBRA - 9th Grade

12/13/62 I think that some provision should be made to break the constant frame study by having a day for tests; a day for discussion, etc. Homogeneous grouping may be the answer so that this can be done. I realize this partially defeats the individual progress idea.

12/14/62 A short period due to an assembly. The remainder of the period was spent in board work by the instructor explaining more in detail factoring of trinomials (this did not expand the unit on factoring) just the preliminary type found in an earlier unit.

12/17/62 The second box seems to be much more clear to the students. At least they seem to go much faster. I'm making up tests as fast as they progress. I hope the standardized tests come soon.

12/18/62 I think ditto copy of supplementary work for every unit should be constructed so that the students could have something to work on over and above the unit itself.

12/21/62 We took another hour of work at the board with various types of problems. Again the students indicated a great interest in this.

1/2/63 The students, after vacation, started in where they left off without much trouble. There seemed to be very little review to refresh their memories.

1/3/63 There seems to be more and more quiet resignation settling in. There is very little eager attitude left. The students work hard and seem to be getting it but don't see the sudden understanding that shows up on some students faces from time to time.

1/7/63 For the second time a sheet was handed out and criticisms were called for. No questions were asked. This was not a structured questionnaire. The students were asked to sign their names this time.

1/9/63 Today I had the students submit questions they would like answered concerning anything in part I of algebra (1st box). On Friday we will take the period to work on these questions and problems. Almost all students have finished box 1. Just a few left working on unit 11 (about 5 students).

I have one student on unit 9 but considering his abilities he is doing wonderful work, in my estimation.

APPENDIX D (continued)

ALGEBRA - 9th Grade

1/11/63 Spent the whole hour in discussion of:
1. Signed numbers (and rules)
2. Multiplication of terms (foil)
    a. monomial factor
    b. binomials
    c. trinomials
3. Factoring
    a. extracting a monomial
    b. difference of 2 squares
    c. general quadratictrinomial
4. The quadratic formula

The students listened attentively and stated they wanted more sessions.

1/16/63 At this point all but 4 students of the twenty-nine are on the second box. (Keeping in mind we started 4 weeks late in the fall, this will give some indication of the time element).

1/18/63 This is the end period of the 2nd 9 weeks. With the exception of 3 or 4, all students seem to have completed 6 units this quarter. This has no particular meaning, just an observation.

1/22/63 A short review of signed numbers is necessary for a few students. This will be done tomorrow.

1/24/63 The class is grouped more now on the units. As a result when one has a question, usually 3 or 4 run into the same question the same hour, so I answer the question on the board orally and let those listen that are interested or are working in that area. The system may not be the best but it breaks the dull "atmosphere".

2/18/63 This long time with nothing to report must indicate something but I don't know what. The students are working in the second box which seems to be programmed better than the first box (part I). Very few questions during this area and they were mostly questions on procedure rather than understanding of the problem.

2/27/63 Today one student informed me that she (_______)is moving to Fargo. She was worried about how this course would fit into the algebra course in Fargo. A short resume will be sent showing what has been covered in the course to date.

APPENDIX D (continued)

ALGEBRA - 9th Grade

3/18/63 The students have developed the idea of self-help in many cases. When they don't do well on a unit they immediately check out a book to work on that area. I make it a point to let them ask rather than ask them. It's amazing.

3/27/63 Today I ran into what (in my opinion) was the first attempt this 2nd semester to cheat. A student was taking a test and hadn't finished it. He has, as have all students returned them to me until the next day when they finished them. This student made an effort to take it out of class to finish it. (No question in my mind.)

4/23/63 Apparently there will be no individual tests for box II. I've made a set of my own.

5/3/63 (_______)finished the course today. He took the final exam (programmed test) and did a reasonably good job. At the present he is studying the slide rule using a Tutortext.

5/17/63 (_________)finished today and is reviewing. Have some enrichment projects available for these students to select when they are finished.

6/3/63 Quite a few students did not finish.

No. of students	Through unit: Box II
1	7
2	8
3	9
7	10
3	11
4	12
2	13
5	finished

With the extra 4 weeks lost in the fall most all of them would have been nearly finished.

APPENDIX D (continued)

ALGEBRA - 10th Grade

10/3/62 All students exhibited enthusiasm and very eager to commence the new course. Some of the students experienced difficulty in operation of the machine. Most difficulty caused by sheets of questions becoming jammed in the internal rollers. This is purely mechanical and I'm sure will work itself out.

10/4/62 Several of the students were disturbed because machines were not functioning properly. A majority of the students concentrated on their work and are progressing rapidly through unit 1.

10/5/62 Half of the class completed unit I without difficulty. Post test revealed those that had completed the unit acquired the necessary understanding of algebraic terminology in unit I.

10/8/62 Students progressing rapidly. All have completed unit 1. Several are almost through with unit 2. Grades on post unit 1 test were B and higher.

10/9/62 It was necessary to explain some algebraic processes in unit 2, also several terms. However, majority of the students are progressing without additional explanations.

10/10/62 As of this date the students appear relaxed and are concentrating upon their work. To date two students have completed unit 3 and will be starting unit 4 Monday.

10/15/62 The growth shown between the pre-unit and the post-unit tests thus far has been encouraging. For example, students on pre-test may get as many as six wrong out of ten questions. On the post test a student may miss one or two or even get all ten questions correct.

10/17/62 All but one student has completed unit 2. Unit 3 appears difficult as the students are requesting explanation of some procedures and terminology.

10/18/62 Grades on post unit tests thus far are running higher than anticipated. Pre test grades were C or better.

10/22/62 Several questions were asked relative to what are algebraic terms and the order of the fundamentals of operation. Otherwise, the students are doing very well in their unit tests.

APPENDIX D (continued)

ALGEBRA - 10th Grade

10/24/62 The students working on unit 6 are encountering some difficulty. One failed to pass the post unit test and is now taking the unit programming over. Removing and restoring parentheses appears to be giving the student the most difficulty.

10/26/62 Enthusiasm diminishing somewhat. Students appear restless the last 15 minutes of the period.

10/29/62 Unit 6 seems to be presenting difficulty. Subject matter deals with equations and parentheses. Understanding of how to clear equations of fractions seems to be giving the students the greatest difficulty.

10/30/62 Today two students failed to pass the post unit test for number 6 unit. Spent ten minutes reviewing material in unit 6 with the two students. Students on the whole are requesting more answers to problems that they do not understand.

10/31/62 Class as a whole is now on units 5 and 6. Rate of speed has slowed down somewhat due to nature of subject matter.

11/1/62 Students working on units 5 and 6. One boy is on unit 8.

11/2/62 Chief difficulty that most of the students are having in unit 6 is the removal of parentheses, collection of similar terms and restoration of parentheses in an algebraic expression.

11/5/62 As more students complete unit 6 it has been necessary for some students to repeat the unit three times because they failed the post unit test.

11/7/62 To date all except one student has completed the first five units. For the type of student enrolled in this class in Washington Senior High there is not enough drill work in the units.

11/9/62 Unit 7 is posing a problem. The four fundamentals of sign numbers is the subject content. It has been necessary for the instructor to answer a multitude of questions relative to sign numbers. Several students that completed the unit ahead of the others had to take the unit over twice before they passed the post test.

11/13/62 Today students were requesting more individual instruction than heretofore, especially units 6 and 7. Majority of my class time was spent giving pupils assistance in clearing up processes that they did not understand.

APPENDIX D (continued)

ALGEBRA - 10th Grade

11/15/62 Spent the period, today and Wednesday, rendering assistance to pupils with questions on units 6 and 7. I'm sure the additional help will be reflected in the post tests.

11/16/62 Three students took the post unit test on 6 and four on unit 7. The high grade that each received was directly affected by the individual instruction from the teacher. Two students completed unit 9. Each scored 8 out of 10 on the post test.

11/19/62 As of this date, 18 of the 29 students have completed seven of the ten units in the first semester programmed instructions. Half of the grade are B or higher. Very pleased with the results. The programmed class has accomplished in 8 weeks what the conventional class required 11 weeks.

11/20/62 Unit 8 has presented a challenge to the students. Subject matter deals with concepts of exponents. The class period was spent answering many questions about exponents.

Two students completed unit 11 the final one in the first semester programmed course.

11/21/62 Two students wrote the post test on unit 11 and obtained a score of 8 out of 10. The completion of unit 11 in the programmed instruction is equivalent to 24 weeks of instructions in the regular course. Unit 11 subject matter has to do with factoring quadratic expressions and solving quadratic equations by factoring.

11/26/62 Four students, in addition to the two that have completed unit 11, took the pre test on unit 11. No change otherwise.

11/27/62 Spent majority of the class period giving individual instruction on units 7, 8, 9 and 11.

11/29/62 For the past three days considerable time has been spent with the students who are the last ones to do units 7, 8 and 9. The slow student appears to be encountering a greater amount of difficulty in understanding the process involved in the mentioned units.

12/3/62 Spent period giving individual instruction on unit 8 and 9 --especially factoring a trinomial.

Administered the post course test to three students. Highest grade was a C.

APPENDIX D (continued)

ALGEBRA - 10th Grade

12/4/62 Although the slow students have requested explanations on many algebraic processes, I'm positive it has been of value in that the students completed the units 7, 8 and 9 their post test scores, the grades have increased.

12/5/62 Before a student who has completed the course for the first semester can write the post course test, I require them to spend two class periods in review. Two more students have completed the course and have written the test. None of the grades were higher than a D.

12/6/62 Seems more and more of my class time is being spent assisting the slower students on the latter units of the program. I'm sure that all the studentss will complete the course by the end of the first semester.

12/10/62 Two more students completed the first semester course in the programmed course. Period spent again in answering questions on units 8, 9 and 11.

12/12/62 Class visited by groups of students from General Beadle College in Madison. Observed the class in progress as they were operating the machines.

12/14/62 All students but eight have completed the first nine units as of this date. Eleven have completed unit 11; leaving seventeen remaining to complete the first semester programming course.

12/17/62 Period spent explaining the fundamental processes in unit 11--factoring and solution of quadratic equation by factoring.

12/19/62 Quite concerned about one student, possibility the student may not complete the ten units. Absent entirely too much. Factoring, again caused difficulty in unit 9 and 11.

12/21/62 Period shortened due to assembly period. Students had about twenty minutes to work in class. Two students have completed units I and II of the second semester program.

1/2/63 To some of the slow students, chapters or units 9 and 11 seem difficult. Grades among the slower students have been C or less. Appear not to understand factoring and solving equations by factoring.

1/4/63 Spent Thursday and today explaining factoring and solving equation by factoring in units 9 and 11. This may improve the results.

APPENDIX D (continued)

ALGEBRA - 10th Grade

1/7/63 As of today, 9 out of the 28 students have completed the course for the first semester. There is some doubt as to whether one girl student will finish the first semester. Absent too much and has other more important things on her mind--boys.

1/9/63 Again, spent considerable time giving individual instructions and explanations to students on units 9 and 11.

1/11/63 Since Wednesday, 10 more students have completed part I of the programmed course. After today, the students have three periods in which to complete the course for the first semester.

1/14/63 All except five of the students completed the units in part I. The students that have not taken the post course test spent the period reviewing.

1/16/63 At the close of the period today all the students have completed part I except three. One has been habitually absent, one has been sick the past two weeks, the other is just plain slow and dense.

1/23/63 Time out for exams. As of this date half the class has completed unit I and II of part II. Several are in unit 3 which appears to be causing them some difficulty. Unit deals with radical and four fundamentals involved therein.

1/25/63 Have a complaint--no preliminary explanation for irrational expressions. All at once in the programming the author requests the student to simplify an irrational expression. Example = $\sqrt{27x^3}$ I think the author should explain this fully. (unit 3)

1/29/63 Student grades on unit tests to date have been somewhat lower than grades near the close of part I. Spent period explaining simplification of radicals.

1/31/63 In general the students have slowed down. The past two days have been spent assisting the students in unit III involving radicals.

2/4/63 Overall progress for the class in unit 3 involving radicals has been slow and tedious for the students. The study of radicals and the various processes so completely different that the student has difficulty understanding what it is all about.

2/6/63 Devoted the past two days, again explaining the processes of radicals. To date but four have completed unit III. This being the fourth week since the start of the second semester, unless the tempo picks up some of the students may be in trouble. Unit 11 must be completed by June.

APPENDIX D (continued)

ALGEBRA - 10th Grade

2/8/63 Majority of students still struggling with unit 3 - (has over 400 frames). Spent class period Thursday and today explaining, explaining, explaining, etc.------

2/12/63 Radicals, radicals and more radicals. With the programming and teachers explanation this unit (3) should be well covered, at least, for the student. Only 10 students have completed unit 3 as of this date.

2/14/63 One student failed unit 3 post test four times. I finally instructed him to go on to unit 4. I'm convinced that he doesn't care whether he passes or fails. Several students have moved to unit 5.

2/18/63 Unit 3 still giving the most difficulty.

2/20/63 Grades on unit 3 overall are very low, however, the students are struggling through.

2/22/63 To break the monotony the class had a discussion on what they think of learning algebra via machines.

2/26/63 With the exception of a few students, the class has completed the first three units. Units 4, 5 and 6 seem to be much easier as compared to Unit III.

2/28/63 Unit tests on 4 and 5 range from C- to B+. The more difficult types of factoring usually required additional assistance from the instructor.

3/4/63 As the instructor, I would like to inject at this juncture that on the basis of material covered that both the controlled and experimental groups grade-wise are about equal. Looking ahead--material covered will be the same.

3/6/63 Unit IV has been a stumbling block to about 1/3 of the class. Entails the four fundamentals of polynomials--majority of the students sought additional assistance.

3/8/63 Approximately 1/4 of the class is now on unit V. This unit deals with factoring polynomials. Students required additional instruction--especially on the more advanced types of factoring.

3/12/63 Units IV and V - four fundamentals of polynomials and factoring--are comparable to the units in the conventional class. Students in programmed class are completing the unit in less time than the conventional class. Programmed time 2 weeks; conventional 3 to 3-1/2 weeks.

APPENDIX D (continued)

ALGEBRA - 10th Grade

3/14/63 Continuing on units IV and V. Some students had to take unit IV over four times before they could pass the post unit test. In general, these students have been having difficulty all along.

3/18/63 A majority of my class period is spent giving individual instructions to students having difficulty with unit V involving factoring.

3/20/63 It has been necessary to give some of the students additional work at the board on the four fundamentals of polynomials and factoring. After completing a particular process--say division--the student does not understand the process.

3/22/63 Again, the period was spent assisting the slower students. Apparently what the slow student needs is more problems to work--repetition in each fundamental process before he fully understands the operations.

3/26/63 Comment for the day--slow students need more problems in a specific operation to become skilled in that particular operation.

3/28/63 Programmed instruction supplemented by individual work at the blackboard or by referring the student to algebra textbooks that are available in class. This is necessary in order that the slower student may master the processes of factoring.

4/1/63 Overall post test on units IV and V are low. Of course, considering the caliber of student that is enrolled in algebra in high school, I consider this par for the course. One of the students completed unit 9 today.

4/3/63 Majority of the students have completed unit IV. Approximately 3/4 of the class found it necessary to take the post test twice before they could pass the test.

4/5/63 The student that completed unit 9 Monday passed unit 10 post test today. Since he desires to enroll in advanced math courses, he will continue through unit 16. Activities again centered around additional assistance to students on unit V.

4/15/63 Yesterday and today have been very successful. Unit 4 has been completed by all the students. Only four students remain to complete unit 5. Factoring and the four fundamentals have been very time consuming for both student and teacher.

APPENDIX D (continued)

ALGEBRA - 10th Grade

4/18/63 In general, my job the past few days has been to teach, reteach, review, recall, explain and what have you in classroom activity. What with the low calibre student in this type of call such procedure can be expected.

4/22/63 The entire class period today was spent assisting students working in units 5 (fractions), unit 6 (fractional equations) and unit 7 (word problems).

4/23/63 Generally, about six students of the class need extra instruction and explanation on every unit they are engaged in working. Perhaps one can say that this is the purpose of programmed instruction--a handicap to most of the students is that they cannot remember from one day to the next.

4/25/63 A student completed unit 11 today which was the goal set for the programmed instruction the second semester. Other students are on units from 5 to 7.

4/30/63 I have one suggestion to make if programmed instruction is to be continued in Washington High School next year---students weak in mathematical fundamentals and word comprehension should not be enrolled in such a course. Just a suggestion mind you.

5/2/63 The past two weeks the slow students have been using their study hall periods as make-up periods to advance their work so they can complete the course by the end of the school term. The response has been very satisfactory and encouraging.

5/6/63 Continue to give assistance to the slow students, however, not as frequently as heretofore. It is my hope that all of the students will complete unit 11 by the latter part of May.

5/8/63 Extra explanation appears necessary every day for the slow learners. At this time of year some of the students that I have would much rather be on the outside than inside the school.

5/10/63 Students have been encouraged to use their study halls as make-up periods in order to complete the course. This group is really a bunch of slow-burners.

5/14/63 Possibility of 90% of class completing the course seems brighter after today. Two-thirds of the class have utilized their study halls to advance themselves in the programming.

5/16/63 A large portion of class period is still devoted to individual instruction.

APPENDIX D (continued)

ALGEBRA - 10th Grade

5/20/63 To date only two students have completed the requirements--through unit 11. As of this date half the class is working on units 7, 8, 9 and 10. Class as a whole seems slow in comprehending the material.

5/22/63 Today two more students completed unit 11. Assistance generally provided to around six students every day. Also, eight students have completed unit 10.

5/24/63 Only five students have not completed unit 9 as of this date. Appears that all students in 7th period class will complete the course except one or two.

5/28/63 The fact that time is now closing in on the students to complete unit 11 has caused many to become concerned. However, many are using their free periods to come from behind. Twelve students have completed unit 10 as of this date. This has been a very slow and difficult course for the caliber of student that enrolls here at WHS.

5/31/63 At the close of the class period it appears that 3/4 of the class will have completed unit 11. Two of the students completed all 16 of the units.

APPENDIX E

TEACHER EVALUATION FORM

TO TEACHERS OF PROGRAMMED INSTRUCTION COURSES:

Enclosed with this material for finalizing your course in programmed instruction you will find a "Teacher Evaluation Form". It is suggested that you read it carefully and consider your answers thoroughly before filling in the form. The answers which you give will be made a part of the final research report in this experiment and will bear directly on the reported results.

Thank you,

Robert W. O'Hare
Administrative Assistant

APPENDIX E (continued)

TEACHER EVALUATION FORM

Title of Program______________________________Name of Teacher_______________

The following questions were designed to help us evaluate the program that you have just gone through with your class. The information that you can furnish will be of great value to us. For each question please check the blank that you feel most adequately describes your opinion. Blank lines have been provided below each question for you to qualify or elaborate on your answers. Please feel free to make any comments that will aid us in determining the value of this program.

Is the subject-matter of the program academically sound?

__________Yes __________No__________Undecided

Comments:____

____

____

Was the level of the subject matter appropriate for your class?

__________Too difficult_________Appropriate__________Too easy

Comments:____

____

____

As contrasted with what you have been able to accomplish with other types of learning material, how much do you feel you were able to get your pupils to learn with this program?

__________A great deal more than with most other materials.

__________A little more than with most other materials.

__________About as much as with other materials.

__________A little less than with most other materials.

__________So little as to be a waste of time.

APPENDIX E (continued)

Comments:____

____

____

The next time you teach a course in this subject or a similar field, would you

__________Prefer to have programs used for at least part of the course?

__________Prefer not to have programs used?

__________Not care whether programs are used or not?

Comments:____

____

____

To what extent did you enjoy using this program with your class?

________	________	________	________	________
Very Unenjoyable	Unenjoyable	50-50	Enjoyable	Very Enjoyable

Comments:____

____

____

Do you think this program should be made available for the use of teachers throughout the country?

__________Yes __________No __________Don't know

Comments:____

____

____

In your own words would you please summarize your opinion of this program. Include statements about its strong and weak points.

APPENDIX F

STUDENT EVALUATION FORM

1. If algebra machines had not been used in algebra class, I believe:

________ I would have learned less in algebra.

________ It would have made no difference.

________ I would have learned more in algebra.

2. In comparing work done using the algebra machines with studying in the textbook, I feel that, with the same amount of time and effort:

________ I learn much more with the machines.

________ I learn somewhat more with the machines.

________ I feel there is no difference.

________ I learn somewhat more from studying textbooks.

________ I learn much more from studying textbooks.

3. If I were to take another course in this subject or a smililar subject, I would:

________ choose to have machines used for at least part of the course.

________ choose not to have machines used.

________ not care whether machines are used or not.

4. How much do you think you learned from using the algebra machines?

________	________	________	________	________
Learned nothing	Learned a little	Learned a medium amount	Learned quite a bit	Learned very much

5. How much did you enjoy going through this program using the algebra machines?

________	________	________	________	________
Very much disliked	Disliked	Don't know	Enjoyable	Very enjoyable

6. In your own words say what you thought of the algebra machines. For example, what did you like about the program? What didn't you like about it, etc.?

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